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STATE DOCUMENTS

**STANDARD
SPECIFICATIONS**

For
**ROAD AND BRIDGE
CONSTRUCTION**

* * *

1962 EDITION

* * *

Adopted by

STATE HIGHWAY COMMISSION

as of

January 1, 1962

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29

STATE OF MONTANA

Donald G. Nutter, Governor

STATE HIGHWAY COMMISSION

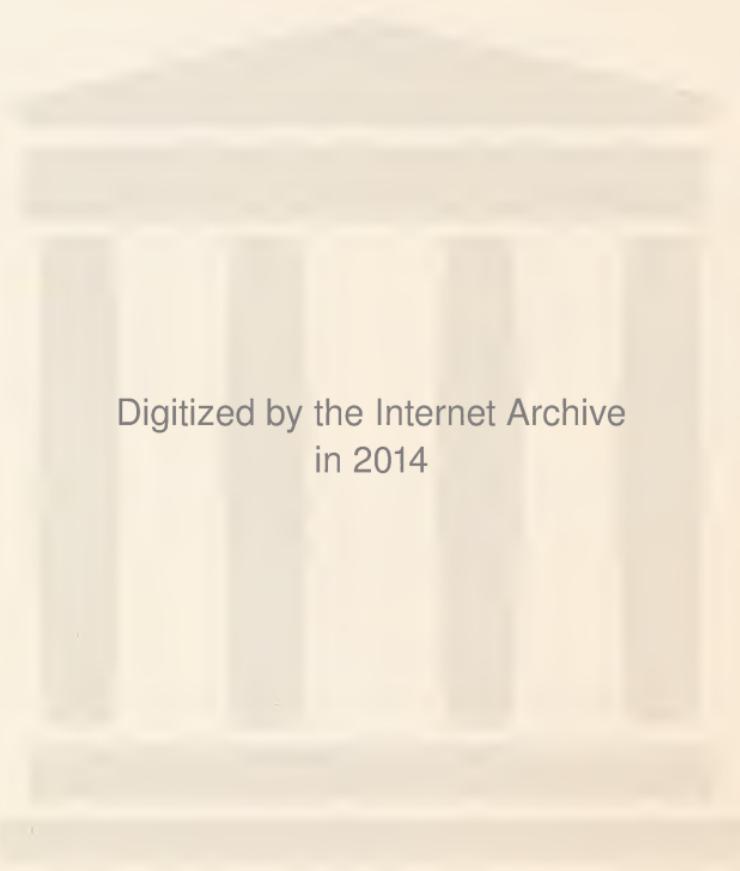
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STANDARD SPECIFICATIONS

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SECTION 1

DEFINITIONS AND TERMS

Whenever, in these specifications and in other contract documents, the following terms, or pronouns in place of them, are used, the intent and meaning shall be interpreted as set forth in the following definitions.

01.01 ABBREVIATIONS. Whenever the following abbreviations are used in these specifications, or plans, or any contractual instruments, they are to be construed the same as the respective expressions represented:

A.A.N.—American Association of Nurserymen

A.A.R.—Association of American Railroads

AASHO—American Association of State Highway Officials
References to AASHO specifications will be abbreviated as follows: "AASHO Designation: M81-42" will be abbreviated to "AASHO M 81."

A.I.A.—American Institute of Architects

A.I.S.C.—American Institute of Steel Construction

A.I.S.I.—American Iron and Steel Institute

A.R.A.—American Railway Association

A.R.E.A.—American Railway Engineering Association

A.S.A.—American Standards Association

References to A.S.A. Specifications will be abbreviated as follows: "A.S.A. Designation: B 18.2 will be abbreviated to ASA B 18.2.

A.S.C.E.—American Society of Civil Engineers

A.S.L.A.—American Society of Landscape Architects

A.S.T.M.—American Society for Testing Materials

References to ASTM Specifications will be abbreviated as follows: "ASTM Designation: D449-49" will be abbreviated to "ASTM D 449."

A.W.P.I.—American Wood Preservers Institute

A.W.W.A.—American Water Works Association

A.W.S.—American Welding Society

B.P.R.—Bureau of Public Roads, Department of Commerce

C.R.S.I.—Concrete Reinforcing Steel Institute

S.A.E.—Society of Automotive Engineers

S.P.R.—Simplified Practice Recommendation and Commercial Standards by U. S. Dept. of Commerce

W.C.L.A.—West Coast Lumbermen's Association

W.C.L.B.—West Coast Bureau of Lumber Grades and Inspection

W.P.A.—Western Pine Association

Specifications prepared and published by many of the above agencies will be referred to in this book of specifications. It shall be understood, as a general rule, that the latest version of such a specification shall prevail without making specific reference by date. Such abbreviations, as herein used for A.S.T.M., A.S.A. and A.A.S.H.O. may be used in other cases.

01.02 ACCESS CONNECTION. Any roadway facility by means of which vehicles can enter or leave an arterial highway. This includes intersections at grade, private driveways and ramps or separate lanes connecting with cross streets or frontage roads.

01.03 CHANGE ORDER. Written authority on an approved form, issued to the contractor by the engineer, directing changes in the work within the provisions of the contract.

01.04 ADVERTISEMENT. The advertisement for proposal for all work or materials on which bids are to be accepted.

01.05 ARTERIAL HIGHWAY. A general term denoting a highway designed primarily for through traffic, usually on a continuous route.

01.06 AUXILIARY LANE. The portion of the roadway, adjoining the traveled way, designed for parking, speed-change, or for other purposes supplementary to movement of through traffic.

01.07 AWARD. The decision of The Commission to accept the proposal of the lowest responsible bidder for the work, subject to the execution and approval of a satisfactory contract therefor and bond to secure the performance thereof, and to such other conditions as may be specified or otherwise required by law.

01.08 BELT HIGHWAY. An arterial highway for carrying traffic, partially or entirely, around an urban area or portion thereof. (Also called circumferential highway.)

01.09 BIDDER. Any individual, firm, partnership, joint-venture, or corporation submitting a proposal for the work contemplated, acting directly or through a duly authorized representative.

01.10 BRIDGE. A structure which provides a waterway, or other opening, and which has a clear span of over 20 feet, measured along its centerline, between the inside faces of abutments, or a multiple span structure of which the sum of the individual clear span plus the aggregate width of the intermediate supports is in excess of 20 feet.

01.11 CALENDAR DAY. Every day shown on the calendar, Sundays and holidays included.

01.12 THE COMMISSION. The State Highway Commission, an administrative agency acting for and on behalf of the State of Montana, as established by legislation and set forth in Section 32-1601, Revised Codes of Montana.

01.13 CONTRACT. The executed written agreement between The Commission and the successful bidder covering the performance of the work and the furnishing of labor and materials, by which the contractor is bound to perform the work and furnish the labor and materials, and by which The Commission is obligated to compensate him therefor at the mutually established and accepted rate or price.

The contract shall include the instruction to bidders, proposal, contract and contract bond, the standard specifications contained in this book, supplemental specifications, special provisions, general and detailed plans, standard drawings and notice to proceed; also any written work orders, change orders and agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

01.14 CONTRACT BOND. The approved form of security furnished by the contractor and his surety as a guaranty of good faith on the part of the contractor to execute the work in accordance with the terms of the contract.

01.15 CONTRACT PERIOD. The period of time (a) from the specified date of commencing work to the date computed by using the specified number of calendar days, or (b) from the stipulated date of commencing work to the specified date of completion. Inclusive dates shall be used, in either case.

01.16 CONTRACT ITEM (PAY ITEM). An item of work specifically described and for which a price, either unit or lump sum, is provided. It includes the performance of all work and the furnishing of all labor, equipment and materials, described in the text of a specification item included in the contract or described in any subdivision of the text of the supplemental specifications or special provisions of the contract. The first two digits of a contract item number (the number preceding the item description in the proposal) correspond to a section number in these specifications.

01.17 CONTRACTOR. Party of the second part to the contract, acting directly or through his agent or employees.

01.18 CONTRACT TIME OR COMPLETION DATE. The number of calendar days shown in the proposal indicating the time allowed for the completion of the work contemplated in the contract.

In case a calendar date of completion is shown in the proposal, in lieu of the number of calendar days, such work contemplated shall be completed by that date.

01.19 CONTROL OF ACCESS. The condition where the right of owners or occupants of abutting land or other persons to access, light, air or view in connection with a highway is fully or partially controlled by public authority.

01.20 CULVERT. Any structure not classified as a bridge, which provides an opening under any roadway.

01.21 DEPARTMENT (HIGHWAY). The functional organization acting for and on behalf of The State Highway Commission.

01.22 DIVIDED HIGHWAY. A highway with separated roadways for traffic in opposite directions.

01.23 EMPLOYEE. Any person working on the project mentioned in the contract, of which these specifications are a part, and who is under the direction or control, or receives compensation from the contractor or subcontractor.

01.24 ENGINEER. The State Highway Engineer, acting directly or through an assistant or other duly authorized representative of The State Highway Commission, such assistant or representative acting within the scope of the particular duties assigned to him or of the authority given him.

01.25 EQUIPMENT. All machinery and equipment, together with the necessary supplies for upkeep and maintenance, including tools and apparatus necessary for the proper construction and acceptable completion of the work.

01.26 VACANT.

01.27 EXTRA WORK ORDER. A written order on an approved form from the engineer to the contractor, concerning either or both the performance of work or furnishing materials not covered by the provisions of the contract.

01.28 FRONTOGE STREET OR ROAD. A local street or road auxiliary to and located on the side of an arterial highway for service to abutting property and adjacent areas and for control of access.

01.29 HIGHWAY. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

01.30 HIGHWAY SEPARATION. Any structure carrying highway traffic over or under another highway or street.

01.31 INSPECTOR. An authorized representative of the engineer, assigned to make any or all necessary inspections of the work performed and materials furnished by the contractor.

01.32 INSTRUCTION TO BIDDERS. Form prepared and furnished by the Department, for the information of bidders submitting proposals. It specifies the provisions, requirements and instructions pertaining to the method, manner and time of submitting bids and approximate quantities of materials required.

01.33 INTERSTATE. The National System of Interstate and Defense Highways.

01.34 INVITATION FOR BIDS. The advertisement for proposals for all work or materials on which bids are required. Such advertisement will indicate, with reasonable accuracy, the type and location of the work to be done or the character of the material to be furnished and the time and place of the opening of proposals.

01.35 ITEM NUMBER. A predetermined number assigned to each and every item of contract work or work done by agreement between the State and the U. S. Bureau of Public Roads.

The item numbers and item descriptions pertaining to the work covered by these specifications are all listed at the back of this book, immediately ahead of the index. Such item numbers and descriptions are not an essential part of the contract and are subject to change, modification, deletion or addition at any time. Correct numbers and descriptions will appear in the proposal for each contract.

01.36 LABORATORY. The main Testing Laboratory of The Commission, located at Helena, or other laboratories of The Commission located at other points throughout the State, or any other laboratory which may be designated by the engineer to make tests of materials and of work involved in the contract.

01.37 MAJOR ITEM. Any item having an original contract value in excess of ten (10) percent of the total original contract amount shall be classed as a major item.

01.38 MATERIALS. Any substances specified for use in the construction of the project and its appurtenances.

01.39 MEDIAN. The portion of a divided highway separating the traveled ways for traffic in opposite directions.

01.40 MEDIAN LANE. A speed change lane within the median to accomodate left-turning vehicles.

01.41 NOTICE TO PROCEED. A written notice to the contractor of the date on which he shall begin the prosecution of The Work.

01.42 NOTICE OF AWARD. A written notice to the contractor notifying him of the acceptance of his proposal and the contract award.

01.43 PLANS. The official approved plans, profiles, typical cross sections, working drawings and supplemental drawings, or exact reproduction thereof, which show the location, character, dimensions, and details of the work to be done, and which are to be considered as part of the contract supplementary to these specifications and which are identified in the proposal. The word "Plans" shall be interpreted to include "Standard Drawings" when referring to documents included in a contract.

01.44 PREQUALIFICATION. The approved form, or forms, upon which the contractor shall furnish the information as to his ability to perform the work, his experience in similar work, the equipment owned, and his financial condition as related to his ability to finance the work.

01.45 PROJECT. The specific section of the Highway together with all appurtenances and construction to be performed thereon under the contract.

01.46 PROPOSAL. The offer of the bidder, submitted on the prescribed proposal form, to perform the work and to furnish the labor and materials at the prices quoted by the bidder.

01.47 PROPOSAL FORM. The approved prepared form, including instruments, forms and instructions attached thereto, on which the bidder is to submit his proposal for the work contemplated.

01.48 PROPOSAL GUARANTY. The security, designated in the proposal, to be furnished by the bidder as a guaranty of good faith to enter into a contract with the State, if the work of constructing the improvement is awarded to him.

01.49 RAILWAY-HIGHWAY SEPARATION. Any structure carrying highway traffic over or under the tracks of any railway.

01.50 RIGHT-OF-WAY. The land secured and reserved to the Public for Highway purposes.

01.51 ROADBED. The graded portion of a highway, usually considered as the area between the intersections of top and side slopes, upon which the base course, surface course, shoulders and median are constructed.

01.52 ROADSIDE. A general term denoting the area adjoining the outer edge of the roadway. Extensive area between the roadways of a divided highway may also be considered roadside. Roadside improvement may include work on the cut and fill slopes as well as the areas outside of the roadway section.

01.53 ROADWAY. The portion of the Highway within limits of construction.

01.54 SHOULDER. That portion of the roadway, contiguous with the traveled way, constructed for the accommodation of stopped vehicles, for emergency use and for lateral support of base and surface courses.

01.55 SPECIAL PROVISIONS. Special directions, provisions or requirements, peculiar to the project under consideration and not otherwise thoroughly or satisfactorily detailed or set forth in the specifications. Special provisions shall prevail over specifications and supplemental specifications, whenever in conflict therewith, and over all plans. They set forth the final contractual intent as to the matter involved.

01.56 SPECIFICATIONS. The general term comprising all the directions, provisions and requirements contained in this Book of Standard Specifications, together with such as may be added or adopted as supplemental specifications or special provisions, all of which are necessary for the proper performance of the contract.

01.57 SPEED-CHANGE LANE. An auxiliary lane, including tapered areas, primarily for the acceleration or deceleration of vehicles entering or leaving the through traffic lane.

01.58 STANDARD DRAWINGS. These are special drawings and sketches, including detailed instructions, where necessary, issued and made available by the engineer to the contractor and other interested persons. They will pertain to certain items of work contained in a contract.

01.59 STATE. The State of Montana acting through its authorized representative.

01.60 STREET. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way, within cities, towns or villages.

01.61 SUBCONTRACTOR. The individual, firm or corporation undertaking the execution of a part of the work under the terms of the contract by virtue of an agreement between himself and the contractor, subject to the approval of the engineer.

01.62 SUBBASE. Materials placed immediately above the subgrade to provide required stability.

01.63 SUBGRADE. The portion of the roadbed prepared as a foundation for the subbase, base and surface courses.

01.64 SUBSTRUCTURE. All of that part of a structure below the bridge seats or below the springing lines of arches. Back-walls and parapets of abutments, and wingwalls, shall be considered as parts of the substructure.

01.65 SUPERINTENDENT. The executive representative of the contractor who is authorized to receive and fulfill instructions from the engineer and who shall supervise and direct construction work.

01.66 SUPERSTRUCTURE. All that part of the structure above the bridge seats or above the springing lines of arches, including the flooring.

01.67 SUPPLEMENTAL AGREEMENT. A written agreement executed by the contractor and the Commission, with the consent of the Surety, covering major changes and supplementing the original contract.

01.68 SUPPLEMENTAL SPECIFICATIONS. Specifications adopted subsequent to the publication of this Book of Standard Specifications. They generally involve new construction items

or substantial changes in the approved specifications. Supplemental specifications shall prevail over the standard specifications whenever in conflict therewith, dependent upon date of issue.

01.69 SURETY. The corporate body bound with and for the contractor, for the full and complete performance of the contract, and for the payment of all debts pertaining to The Work. When applying to the "Proposal Guaranty" it refers to the corporate body which engages to be responsible in the execution by the bidder of the contract documents.

01.70 SURFACING. Any material superimposed on the sub-base or base for its consolidation but functioning primarily as a support for vehicular traffic.

01.71 THE WORK. "The Work" shall be understood to mean the furnishing of all labor, materials, equipment, manipulations and other incidentals necessary or convenient to the successful completion of the Project in accordance with the specifications and the carrying out of all the duties and obligations imposed by the contract.

01.72 TRAFFIC LANE. The portion of a traveled way designed for the movement of a single line of vehicles.

01.73 TRAVELED WAY. The portion of the roadway, exclusive of shoulders and auxiliary lanes, designed for the movement of vehicles.

01.74 WORKING DAY. A calendar day, exclusive of Sundays and State recognized legal holidays on which weather and other conditions not under the control of the contractor will permit construction operations to proceed for the major part of the day on the principal item or items of work which would normally be in progress at that time.

01.75 WORKING DRAWINGS. Stress sheets, shop drawings, erection plans, false-work plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the contractor is required to submit to the engineer for approval.

01.76. In order to avoid cumbersome and confusing repetition of expressions in these specifications, whenever it is provided that anything is, or is to be, or to be done, if or as, or when, or where "authorized," "contemplated," "required," "directed," "specified," "considered necessary," "deemed necessary," "permitted," "suspended," "approved," "acceptable," "unacceptable," "suitable," "unsuitable," "satisfactory," "unsatisfactory," or "sufficient," it shall be understood as if the expressions were followed by the words "by or to the Engineer with the approval of The Commission."

01.77. Wherever in these specifications appear references such as the following examples: 1. "Equipment (a)," "Aggre-

gate Surfacing," it shall be understood to have been prefixed with and specifically mean, "of the Part (A) of the Specifications Section "Aggregate Surfacing" or example 2. "shall conform to the requirements of Concrete," shall have been prefixed with and mean (of the Specifications Section "Concrete"), etc. This form is adopted for purposes of simplicity and elimination of needless repetition.

01.78. It shall be understood thoroughly by all concerned that all things contained herein, together with the "Invitation for Bids," or "Instruction to Bidders," "Special Provisions," "Supplemental Specifications," and the "Contract Bond" as well as any papers attached to or bound with any of the above, also any and all supplemental agreements made or to be made, are hereby made a part of these specifications and contract, and are to be considered one instrument.

01.79. This book of standard specifications is divided into sections, each pertaining, generally to a specific subject. Each section is, in turn, divided into ARTICLES covering specific portions of the subject matter. Many ARTICLES will be divided into Parts and numbered or lettered. For example, See Section 34, Road Mix Bituminous Surfacing; (ARTICLE) 34.01 DESCRIPTION; (ARTICLE) 34.02 MATERIAL etc. (ARTICLE) 34.05 CONSTRUCTION METHODS is subdivided as follows:

- (ARTICLE) 34.05 CONSTRUCTION METHODS
 - (Part) 34.05 (A) Limitations and Conditions.
 - (Part) 34.05 (A) (1) Weather Season and Time.
 - (Part) 34.05 (A) (2) Scope of Operations.

A reference, elsewhere in this book to (2) "Scope of Operations" will be briefed to "Article 34.05(A)(2). The word "ARTICLE" is placed before a number by implication only.

SECTION 2

PROPOSAL REQUIREMENTS AND CONDITIONS

02.01 CONTENTS OF PROPOSAL FORM. The bidder will be furnished with a proposal form which will state the location and description of the contemplated work, and which will show the approximate estimate of the various quantities of the work to be performed and the materials to be furnished, the amount of "Proposal Guaranty" (which must accompany the proposal) and the date and time of the opening of proposals. It will also state any special provisions or requirements which vary from or are not contained in the standard and/or supplemental specifications. All papers bound with or attached to the proposal form are a necessary part thereof and must not be detached. The proposal form, as issued to the prospective bidder, will not actually contain the standard specifications, supplemental specifications, or plans but they shall, by this reference be incorporated into and made a part of each and every proposal form.

02.02 INTERPRETATION OF ESTIMATE. The quantities scheduled in the proposal are to be considered as approximate and as prepared for the comparison of bids only. The unit prices to be tendered by the bidder are to be tendered expressly for the scheduled quantities as they may be increased or decreased within the restricting percentage hereinafter stipulated. Payment to the contractor will be made for the actual quantities only of work performed or materials furnished in accordance with the contract, and it is understood that the scheduled quantities of work to be done and materials to be furnished may each be increased or diminished as hereinafter provided without in any way invalidating the bid prices.

02.03 EXAMINATION OF PLANS, SPECIFICATIONS AND SITE OF WORK. The bidder is required to examine carefully the site of, and the proposal, plans, specifications and contract for, the work contemplated. It will be assumed that the bidder has made said examination and is satisfied as to the conditions to be encountered in performing the work as scheduled or as at any time altered without resulting in increases or decreases of more than the restricting percentage hereinafter stipulated, and to the character, quality and quantities of work to be performed and materials to be furnished, including increases and decreases, and as to the requirements of these specifications, special provisions, supplemental specifications and contract. It is mutually agreed that submission of a proposal shall be considered *prima facie* evidence that the bidder has made such examination and is satisfied as to all the conditions and contingencies.

02.04 PREPARATION OF PROPOSAL. The bidder must submit his proposal on the form furnished by The Commission. The blank spaces in the form must be filled in correctly for each and every item for which a quantity is given, and the bidder must state the prices (written both in words and numerals) for which he proposed or proposes to do each item of work contemplated. All proposals must be extended and totaled, and it is understood that, in cases of errors or discrepancies in extension, the unit prices written in words shall be held as governing.

When an item in the proposal contains a choice to be made by the bidder, the bidder shall indicate his choice in accordance with the specifications for that particular item, and thereafter no further choice will be permitted.

The bidder must sign his proposal correctly, showing his name and postoffice address. If the proposal is submitted by a firm, partnership or joint-venture, the name and postoffice address of each member of the firm, partnership or joint-venture must be shown; if submitted by a corporation, the name of the State under the laws of which the corporation was chartered, and the names, titles and business addresses of the President and Secretary must appear.

All persons or firms desiring to qualify or bid on highway construction contracts on the basis of a Joint Venture shall be required to execute a "Declaration of Joint Venture and Power of Attorney" which said instrument shall designate a name under which the members of the Joint Venture desire to do business with the State Highway Commission and also which said instrument shall appoint a specifically designated person who shall be authorized to execute all bids and contracts with the State Highway Commission on behalf of all members of the Joint Venture and which person shall be authorized to receive all moneys due from the State Highway Commission to the Joint Venture, and to issue binding receipts and releases therefor.

02.05 REJECTION OF PROPOSALS CONTAINING IRREGULARITIES. Proposals may be considered irregular and may be rejected for the following reasons:

- (a) If the Proposal furnished is not used or is altered.
- (b) If there are unauthorized additions, conditional or alternate bids, or irregularities of any kind which may tend to make the proposal incomplete, indefinite or ambiguous as to its meaning.
- (c) If the proposals for two or more projects, advertised separately, are connected, or made contingent one upon the other, in such manner that the proposal for any particular project shall carry a provisional deduction in the bid price on one or more of the other projects.

(d) If the bidder adds any provisions reserving the right to accept or reject an award or to enter into a contract pursuant to an award.

(e) If the unit prices contained in the proposal are obviously unbalanced, either in excess or below the reasonable cost analysis value.

(f) If they fail to contain a unit price for every pay item indicated, except in the case of authorized alternate pay items.

02.06 PROPOSAL GUARANTY. No proposal will be considered unless accompanied by a proposal guaranty, in the amount stipulated by the proposal, made unconditionally payable to the State Highway Commission, which at the bidder's option may be cash, cashier's check, certified check, postal money order, bank money order, express money order, bank draft, or any other guaranty that may be especially approved by the Commission. Alteration of the proposal form as required to provide for the form of guaranty will be allowed.

02.07 DELIVERY OF PROPOSALS. Each proposal must be submitted in a special envelope furnished by The Commission. The blank spaces on the envelope must be filled in correctly so as to indicate its contents clearly. If forwarded by mail, the above-mentioned envelope may be enclosed in another, addressed to The State Highway Commission, Helena, Montana; if forwarded otherwise than by mail it shall be delivered at the office of The State Highway Commission, Helena, Montana. Proposals will be received until the time stipulated in the advertisement for the opening thereof.

Any bid which arrives by mail after the time affixed for opening, but before award is made, and it is shown to the satisfaction of The Commission authorized to make the award that the non-arrival on time was due solely to delay in the mails for which the bidder was not responsible, such bid will be received and considered. No responsibility will attach to The Commission for the premature opening of a bid not properly addressed and identified. Unless specifically authorized, telegraphic bids will not be considered, but modifications by telegraph of bids already submitted will be considered if received prior to the hour set for opening.

02.08 WITHDRAWAL OF PROPOSALS. Bidders may withdraw any proposal after it has been deposited with The Commission, provided the bidder makes his request to The Commission prior to the time of opening the proposals on the particular project; and at the time of the opening of the proposals, when such proposal is reached, it will be returned to the bidder unopened and unread.

02.09 PUBLIC OPENING OF PROPOSALS. Proposals will be opened publicly and read at the time and on the date set in the invitation for bids by The Commission in Helena, or at such other place as may be designated in the invitation for bids.

02.10 DISQUALIFICATION OF BIDDERS. More than one proposal from an individual, a firm, partnership, joint-venture, a corporation or an association under the same or different

names will not be considered. If it shall be found that any bidder is interested in more than one proposal for the work contemplated, The Commission will cause the rejection of all proposals in which such bidder is interested. Any or all proposals will be rejected if there is reason for believing that collusion exists among the bidders and all participants in such collusion will not be considered in future proposals for the same work.

02.11 CONDITIONAL BIDS. A bidder who desires to bid upon more than one project at a single letting but who desires to protect himself against receiving the award of more projects than he is equipped to handle may bid upon any number of projects, securing the protection desired by making the following written statement signed by the bidder and attached to the proposal for each of the projects bid on:

"This bid is conditional upon my (or our) receiving the award for only (insert number of projects) of the projects bid upon at this letting. If the contract for any other project, or projects, up to the number herein specified, is awarded to me (us), then this bid shall be considered withdrawn."

In case a bidder who has conditioned his bid, as above provided, is low bidder on several projects, it shall be optional with The Commission as to which of the projects is awarded him.

02.12 COMPETENCY OF BIDDERS. No contract will be awarded except to a responsible bidder capable of performing the work contemplated. Each prospective bidder shall submit, on a form furnished by The Commission, a certified statement of qualifications. This statement must be submitted to The Commission at least seven calendar days prior to the date of opening bids on proposed work. The preparation and submission of all prequalification statements shall conform to current rules and regulations of The Commission.

The certified statement will be considered an essential part of the bid and failure to submit the statement prior to the time specified by The Commission shall be deemed sufficient cause for rejection of the bid without reading it.

02.13 MATERIAL GUARANTY. Before any contract is awarded the bidder may be required to furnish a complete statement of the origin, composition, and manufacture of any or all materials to be used in the construction of the improvement, together with samples which may be subjected to the tests provided for in these specifications to determine their quality and fitness for the work.

SECTION 3

AWARD AND EXECUTION OF CONTRACT

03.01 CONSIDERATION OF BIDS. The comparison of bids will be based on the correct extension and summation of all items included in the proposal at prices bid. The Commission reserves the right to reject any or all proposals, or to waive technicalities, as may be deemed best for the interest of the State.

03.02 AWARD OF CONTRACT. All contracts will be awarded by The Commission, to the lowest responsible bidder, within forty-five (45) days from the date of the opening of the proposals; provided, however, that should no award be made within forty-five (45) days, all proposals will be rejected.

03.03 RETURN OF PROPOSAL GUARANTY. All "Proposal Guaranties" except those of the three (3) lowest bidders will be returned within three (3) days following the date of opening bids. Should no award be made within forty-five (45) days, all proposals will be rejected and all guaranties returned.

03.04 CONTRACT BOND REQUIRED. The successful bidder, at the time of the execution of the contract, must deposit with The Commission a surety bond for the full amount of the contract. The form of bond shall be that provided by The Commission and the surety must be acceptable to The Commission. The surety bond must be executed by a surety company authorized by law to transact such business in the State of Montana.

03.05 EXECUTION OF CONTRACT. The individual, firm, or corporation to whom or to which the contract has been awarded shall enter into a contract with The Commission within ten (10) days after receipt of the contract documents. No proposals shall be considered binding upon The Commission until the execution of the contract.

03.06 APPROVAL OF CONTRACT AND BOND. The contract shall be subject to the approval of The Commission's Attorney, after execution by the contractor and by the Chairman of The Commission. The bond shall be approved likewise after execution by the contractor and surety.

03.07 FAILURE TO EXECUTE CONTRACT. Failure to execute the contract or give satisfactory security, as specified, shall be just cause for annulment of the award, or of the contract, if executed, and in the event of such annulment of the award, or of the contract, the proposal guaranty shall be forfeited to the State, not as a penalty, but as liquidated damages. Award may then be made to the next lowest responsible bidder or the work may be readvertised and constructed under contract, or otherwise, as The Commission decides.

SECTION 4

SCOPE OF WORK

04.01 INTENT OF PLANS AND SPECIFICATIONS. The contractor shall do all clearing and grubbing, make all excavations and embankments, do all shaping and surfacing, construct all ditches, drainage structures, bridges, and other appertaining structures, as indicated in the proposal and on the plans; remove obstructions from within the lines of the Highway and shall do such additional, extra and incidental work as may be considered necessary to complete the roadway to the proper lines, grades and cross sections in a substantial and workman-like manner. He shall furnish, unless otherwise provided, all implements, machinery, equipment, tools, material and labor necessary to the prosecution of The Work. In short, the contractor shall construct the improvement in strict accordance with the plans, specifications, supplemental specifications, special provisions and contract and, when completed, shall leave it in a neat and finished condition. It shall be understood that the work to be done shall not necessarily be limited to within the Highway boundaries.

04.02 SPECIAL WORK. Should any construction or conditions which are not covered by the standard specifications or supplemental specifications be anticipated on any proposed work "Special Provisions" for such work will be made a part of the proposal and shall be considered a part of the standard specifications or supplemental specifications the same as though contained fully therein. Should any such special provisions or requirements conflict with the aforesaid specifications, the special provisions shall govern.

04.03 CONSTRUCTION CHANGES AND ALTERED QUANTITIES. It is mutually agreed that it is inherent in the nature of highway construction that some changes in the plans and specifications may be necessary during the course of construction to adjust them to field conditions and that it is of the essence of the contract to recognize a normal and expected margin of change. The engineer reserves the right to make such alterations in the plans or in the quantities of work as may be considered necessary. Such alterations shall be in writing and shall not be considered as a waiver of any conditions of the contract nor to invalidate any of the provisions thereof.

Therefore, it is mutually agreed that upon demand of either party, an equitable adjustment, satisfactory to both parties, shall be made in the basis of payment if any of the following conditions exists: (1) an increase or decrease of more than twenty-five (25) percent in the length of the project; (2) an increase or decrease or more than twenty-five (25) percent of the total cost of the work, calculated from the original proposal quantities and the contract unit prices; (3) an increase or decrease of more than twenty-five (25) percent of the quantity of any one major contract item, including earth or common

roadway excavation as defined by Subsection 11.00, but not including excavation of any other class or items of foundation piling. In the case of an increase, any adjustment in payment shall apply only to the related quantities of work performed in excess of the stated percentage. In the event of a decrease, any adjustment in payment shall apply to the quantity or quantities of work actually performed. A supplemental agreement (see Article 01.67) will be necessary whenever any one of the aforementioned conditions exists. Alterations involving an increase or decrease of more than twenty-five (25) percent in the quantity of any one minor contract item will not require a supplemental agreement. Upon the execution of a supplemental agreement covering an increase in the amount of work, the contractor must deposit with the Commission a surety bond fully covering the increased amount of work contemplated by the agreement.

A change order (See Article 1.23) will be required when there is contemplated a substantial change in any item of the contract, including changes in types or kinds of materials and major changes in design. The change order may also include "Work by Agreement" for either or both material and additional work not covered by any item in the contract and for which a price can be agreed upon by the contractor and the engineer. Each and every agreed price shall be fully substantiated.

If prices cannot be agreed upon, or where such method of payment is not practicable, extra work shall be accomplished on a force account basis. (See Extra Work Order—Articles 01.27, 04.04 and 09.06.)

04.04 EXTRA WORK. The contractor shall perform extra work, for which there is no quantity and price included in the contract, whenever the same is ordered in writing by the engineer, and such extra work shall be done in accordance with the specifications therefor, or as directed. Such work shall be performed on a force account basis and paid for at prices agreed upon in writing by the contractor and the engineer. (See Article 09.06). If the estimated amount of the extra work exceeds twenty-five (25) percent of the total value of the total contract amount, then said work will be performed under a supplemental agreement. The State shall not pay for, nor shall it be liable for, any extra work performed in the absence of, or prior to, a written authorization or order by the engineer to the contractor covering such work. All extra work done on a force account basis shall be adjusted daily upon report sheets furnished to the engineer by the contractor and signed by both parties. These daily reports shall be considered the true record of extra work.

04.05 CONSTRUCTION AND MAINTENANCE OF DETOURS. Any existing road, while undergoing improvement, shall be kept continuously open to public traffic by the contractor if public traffic was using said road at the time the contract was awarded; provided, however, that, except where otherwise in-

dicated on the plans, the contractor may bypass traffic over a detour approved by the engineer. The contractor shall keep the road undergoing improvement, or the detour, as the case may be, continuously in a condition satisfactory to the engineer, that traffic will be accommodated during the entire contract period; he shall provide and maintain in safe condition temporary approaches and crossings; he shall keep open, and safely passable, intersections with trails, roads and highways; provided, however, that snow removal will not be required of the contractor for the accommodation of traffic. The contractor shall bear all expense of constructing and maintaining such road, detours, approaches, intersections, and any accessory features without direct compensation, save as provided in (A) or (B) below.

(A) Special Detours. When the proposal form contains an item for "Maintenance of Detours", or "Removing Existing Structures and Maintaining Traffic", then the price bid for such item shall cover all cost of constructing and maintaining such detour or detours, including the construction of any and all temporary bridges and accessory features and the removal of the same, and obliteration of the detour road, provided, however, that the contractor will not be required to provide right-of-way for temporary highways or bridges called for under this paragraph. All or any portion of an existing structure that is suitable for use may be utilized in the detour; however, any modification of an existing structure or construction of a temporary structure shall be approved by the engineer prior to executing The Work.

(B) Suspension of Work. Should the engineer, on account of unfavorable weather or other conditions not the fault of the contractor, authorize a suspension of construction operations the contractor shall make passable and shall open to traffic such portion of the Highway under improvement and such temporary roadways or portions thereof as may be agreed upon between the contractor and the engineer for the temporary accommodation of necessary traffic during the anticipated period of suspension, unless otherwise provided in the specifications. Thereafter and until the issuance of an order for the resumption of construction operations, the maintenance of the temporary route or line of travel agreed upon shall be by and at the expense of the State. When work is resumed the contractor shall, at his own cost and expense, replace or renew any work or materials lost or damaged because of such temporary use of the Highway under improvement; shall remove any work or materials used in the temporary maintenance thereof by the State; and shall complete the improvement in every respect as though its prosecution had been continuous and without interference. Provided, however, that this paragraph shall not apply where the contract contains an item for "Maintenance of Detours" or "Removing Existing Structures and Maintaining Traffic" in which case the contractor shall be responsible for the maintenance of traffic during the entire term of his contract.

If the contractor fails to comply with the provisions of this section, the engineer will immediately notify him that he must comply with the required maintenance provisions. Should the contractor fail to remedy unsatisfactory maintenance within twenty-four (24) hours after issuance of such notice, the engineer will immediately proceed with adequate forces and equipment to maintain the roadway or structure in a satisfactory and acceptable manner and the entire cost of this maintenance will be deducted from any moneys due the contractor.

The contractor shall be liable and responsible for all necessary maintenance of the road under construction or any designated detours, either of which is subject to use of public traffic, during all shut-down periods excepting those of seasonal duration.

04.06 REMOVAL AND DISPOSAL OF STRUCTURES AND OBSTRUCTIONS. All obstructions, buildings, structures, fences, building foundations, debris, rubbish, rubble, junk, or any other material not intended to be a part of the completed highway shall be removed and disposed of by the contractor as specified or to the satisfaction of the engineer. The basements of former buildings, trenches, and other holes or excavations which are not to be a part of the finished highway shall be filled and finished to the satisfaction of the engineer.

Payment of the work covered by the terms of the preceding paragraph, unless provided otherwise by the contract, shall not be paid for as separate work but shall be considered as included in the prices bid for other items.

04.07 RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK. The contractor may use, in the construction of the surface or structures, any suitable stone, gravel, sand, timber or other materials found on the project that meet all the requirements of the specifications relating to character and quality for the particular use intended. Materials so used and paid for under some other item, will not be paid for as "Excavation", "Clearing", "Riprap", etc., except that when materials contemplated for use in embankments are otherwise used by the contractor with the result that borrow, not originally contemplated, is necessitated the contractor will be paid on a basis that is most economical for the State. The contractor shall not excavate or remove any material from within the Highway which is not within the excavation as indicated by the slope and grade lines, without written authorization by the engineer. In no instance will an item be paid for under dual identity.

04.08 FINAL CLEANING UP. Upon completion of The Work and before acceptance and final payment shall be made, the contractor shall clean and remove from the highway and adjacent property, at no extra cost to the State, all surplus and discarded materials, rubbish, and temporary structures, restore in an acceptable manner all property, both public and private, which has been damaged during the prosecution of The Work and shall leave the Highway in a neat and presentable condition throughout its entire length.

If any gravel pit, or aggregate quarry is so located as to be visible from the Highway, special care shall be taken by the contractor in making the final cleanup. The gravel or aggregate shall be taken out so as to leave the side banks with as uniform lines as possible and, if required by the engineer in order to produce a neat appearance, the side banks shall be neatly trimmed. The floor of the pit shall be left smooth and all piles of rock, wasted because they were too large to be handled by the crusher, shall be spread neatly over the floor of the pit or otherwise disposed of so as not to present an unsightly appearance. The stripplings from all pits visible from the Highway shall be neatly spread over the adjacent territory or shall be dragged into the pit and there spread as directed by the engineer unless the engineer orders that the stripplings be left in ridges in order to act as wind breaks and snow barriers. No extra compensation shall be allowed for the final cleaning up of the pits or quarries but the cost thereof shall be included in the unit price bid for the materials in the finished course or courses. No contractor shall make any agreement with any landowners unless the prescribed cleanup shall be agreed upon and done.

SECTION 5 CONTROL OF THE WORK

05.01 AUTHORITY OF ENGINEER. All work shall be done under the direction of the State Highway Engineer (hereinafter called the "engineer"), the official engineer of The Commission, and his authorized assistants. His decision as to the construction or meaning of the plans, standard specifications, supplemental specifications and special provisions shall be final. Any additional plans, drawings and explanations as may be necessary to detail and illustrate the work to be done shall be furnished by the engineer and the contractor shall conform to and abide by the same so far as they may be consistent with the purpose and intent of the original plans, standard specifications, supplemental specifications and special provisions. To prevent misunderstanding and litigation, the engineer shall decide any and all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the manner of performance and rate of progress of said work. The engineer's decision shall be final and conclusive, except that the contractor shall not be estopped from resorting to legal process in the event that the decision of the engineer with respect to the matters set forth above is not acceptable.

05.02 PLANS AND WORKING DRAWINGS. Plans and working drawings will be furnished by the Department and in all cases they will form a part of the contract. The plans will show, in detail, minor structures, alignments, grades, cross sections and typical cross section of improvement. Bridge plans will be furnished and will show the general layout and features and all necessary details pertaining to structures. Such supple-

mentary bridge and falsework plans, shop details, etc., as may be necessary shall be furnished by the contractor, but shall not be used until after approval of the engineer. No extra compensation will be allowed for such drawings. Alterations authorized by the engineer will be endorsed on approved plans or shown on supplementary sheets. Additional details relative to working drawings will be furnished as required. It shall be expressly understood that the approval by the engineer of the contractor's working drawings relates to the requirements for strength and detail and such approval will not relieve the contractor from the responsibility for errors in dimensions.

05.03 CONFORMITY WITH PLANS AND ALLOWABLE DEVIATIONS. The approved plans, profiles, and cross sections will show the location, details and dimensions of The Work contemplated. The contractor shall perform all work and handle all labor in the best and most workmanlike manner and all conditions concerning materials and labor involved in the project shall be in strict and entire conformity, in every respect, with the plans, standard specifications, supplemental specifications and special provisions and shall be subject to the inspection and approval of the engineer. Any deviation from the plans, that may be required by the exigencies of construction will, in all cases, be determined by the engineer and authorized in writing.

05.04 COORDINATION OF SPECIFICATIONS, PLANS AND SPECIAL PROVISIONS. All requirements of the plans, specifications and special provisions shall be binding upon the contractor. On all plans and drawings the figured dimensions shall govern in case of discrepancy between figured dimensions and scaled dimensions. Modifications of these standard specifications may be indicated in the plans, supplemental specifications or the special provisions for a particular contract. (See Articles 01.55 and 01.68). In every case of such modifications, or of discrepancies between the standard specifications and the plans and special provisions, the plans shall govern over the standard specifications, the supplemental specifications over the standard specifications, and the special provisions shall prevail over all. The contractor shall not take advantage of any error or omission in the plans or of any discrepancy between the specifications and plans, and the engineer shall make such corrections and interpretations, in full accordance with the principles described in this Article, as may be deemed necessary for the fulfillment of the contract as a whole, as construed by him, and his decision shall be final.

05.05 COOPERATION BY CONTRACTOR. The contractor will be supplied, by the engineer, with five sets of approved plans and special provisions, including authorized alterations thereof—one set of which the contractor shall keep available on The Work at all times during its prosecution. He shall give the work his constant attention and shall cooperate with the engineer in every way possible.

The contractor shall have on the job site, at all times during his absence from The Work during its prosecution, a superintendent, in active charge, who is capable of reading and thoroughly understanding the plans and specifications. The contractor shall notify the engineer, in writing, in advance of the start of work or, in advance of his absence, the name of his superintendent who shall be on the job site at all times while The Work is in progress. The superintendent shall have full authority to execute orders or directions of the engineer without delay and to promptly supply such materials, tools, plant equipment and labor as may be required to satisfactorily perform The Work.

When the contractor is comprised of two or more persons, co-partnerships or corporations, functioning on a joint venture basis, the contractor shall designate, in writing to the engineer, the name of the superintendent who shall have authority to direct The Work and receive orders from the engineer to be received and obeyed by the contractor.

Where two or more contractors are engaged upon work on the same project, or section of project, or upon work in the same vicinity, each shall be responsible to the other for any damage, injury, loss or expense which may be suffered on account of interference of operations, neglect or failure to finish work at the proper time, or for any other reason. Each contractor shall confine storing of materials, tools, machinery or other equipment to his own respective right-of-way or other area outside of the Highway so as not to interfere with or impede the work of the other.

05.06 CONSTRUCTION STAKES. The engineer will furnish and set all survey and grade stakes necessary for the guidance of the contractor in the prosecution of The Work. The contractor shall furnish, free of charge, all templates and materials other than stakes necessary for marking and maintaining points and lines given; and, without expense to The Commission, shall furnish the inspector such assistance or assistants as may be required in giving points and lines necessary to the prosecution of The Work. The contractor shall be held responsible for the preservation of all stakes and marks and if, in the opinion of the engineer, any of the survey stakes or marks have been carelessly or wilfully destroyed or disturbed by the contractor the cost to The Commission of replacing them will be charged against him and deducted from the payment for The Work. Finished surfaces, in all cases, shall conform to the lines and grades given and as shown on the approved plans.

The crown rise of the finished surface of the roadways, from the curb or side-line to the center, shall be as shown on the typical cross section of the plans, except at intersecting highways, or wherever, to insure correct drainage or for other reasons, changes may be directed. On curves or at other places where deemed necessary, the contractor may be required to super-elevate one side of the roadway so that finished surface shall slope in one direction.

05.07 AUTHORITY AND DUTIES OF INSPECTORS. Inspectors, employed by The Commission, will be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or any part of The Work and to the preparation or manufacture of the materials to be used; but such inspection shall not relieve the contractor from any obligation to perform all of The Work strictly in accordance with the requirements of the contract. In case of any dispute arising between the contractor and the inspector as to materials furnished, or the manner of performing The Work, the inspector shall have the authority to reject materials or suspend prosecution of the particular work affected until the questions at issue can be referred to and decided by the engineer. The inspector shall not be authorized to revoke, alter, enlarge, or relax any requirements of the contract, nor to finally approve or accept any portion of work, nor to issue instructions contrary to the provisions of the plans and specifications. Any advice inconsistent with the requirements of the contract, which the inspector may give the contractor, shall in no wise be construed as binding the engineer or The Commission in any way, nor releasing the contractor from the fulfillment of the terms of the contract. The inspector shall not be authorized to act as foreman for the contractor, nor to interfere with the management of The Work.

05.08 INSPECTION. (A) The contractor shall furnish the engineer with every reasonable facility for ascertaining whether The Work, as performed, is in accordance with the requirements and intent of the contract. Any work done or materials used without suitable supervision or inspection by a Commission representative may be ordered removed and replaced at the contractor's expense. All offices and laboratories furnished and maintained under the provisions of this Article shall be furnished by the contractor as a contractual obligation and shall remain his property upon completion of the Project.

(B) Field Laboratory on Grading Projects. Unless specified otherwise, the contractor shall provide and maintain, at the site of The Work and at a location designated by the engineer, a building for use as a field laboratory for testing soil samples. This building shall have a minimum floor area of 60 square feet with a minimum dimension of 6 feet. It shall be equipped with heating facilities when needed, including fuel, a work bench across one end, two chairs, lighting facilities and light. It shall be so constructed as to be movable on the Project. If the engineer determines that the building described in Part (C) will suffice, this building will not be required.

(C) Field Laboratory on Surfacing Projects. Unless specified otherwise, the contractor shall provide and maintain, at the site of The Work and at a location designated by the engineer, a building or trailer house for exclusive use as a field laboratory by the engineer. The laboratory shall have a minimum inside floor area of 100 square feet and a minimum inside

dimension of 6 feet and shall be well constructed and weather-proof. It shall be constructed so that it may be moved from one point to another on the Project and shall be fitted with a door and windows and equipped with a work bench and chairs, a two-burner bottled-gas plate complete with tank and fuel for drying materials, a stove and fuel for heating, when required and an adequate easily accessible supply of water to be used for the testing of materials.

(D) Field Office For Bridge and Structure Projects. Unless specified otherwise, the contractor shall provide an office having a minimum floor area of 150 square feet, with a minimum dimension of 7 feet, for the sole use of the engineer during the entire construction period. The structure shall be reasonably weather-tight, and the construction shall be such that it may be easily heated. It shall be fitted with a door and not less than three windows which can be opened for ventilation. The windows and door shall be equipped with screens when needed. It shall be equipped with an adequate bench, table, two chairs, lighting facilities, and an automatic oil or gas burning stove and all fuel required for the entire construction period, including shut-down periods. The office shall be located at a convenient site acceptable to the engineer.

05.09 REMOVAL OF DEFECTIVE AND UNAUTHORIZED WORK. Work done without lines and grades being given, or beyond the lines shown on the plans or as given, except as herein provided, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. All materials not conforming to the requirements of the specifications shall be considered as defective and all such materials, whether in place or not, will be rejected and shall be removed immediately from the Highway unless otherwise permitted. All work which has been rejected or condemned shall be remedied or, if necessary, removed and replaced in an acceptable manner by the contractor at his own expense. Upon failure on the part of the contractor to comply promptly with any order of the engineer made under the provisions of this section, the engineer shall, after giving written notice to the contractor, cause defective work to be remedied, or removed or replaced, or cause unauthorized work to be removed and shall deduct the cost thereof from any compensation due or to become due the contractor.

05.10 PLANT AND EQUIPMENT. The contractor shall provide suitable equipment and plants adequate to produce acceptable work and materials in the required quality and quantity when ordered by the engineer, and shall remove unsuitable equipment from the Project and discontinue the operation of unsatisfactory plants.

05.11 FINAL INSPECTION. Final inspection of the work will be made by the engineer or his authorized assistant within fifteen days after the final cleanup following completion of the Project.

SECTION 6

CONTROL OF MATERIAL

06.01 SOURCE OF SUPPLY AND QUALITY. (A) General.

All materials which are to be used on or incorporated into a project shall conform to the specifications and/or be approved by the engineer. Attention is directed to Article 20.02(A) concerning the sampling and testing of surfacing aggregates. The material, at the source of supply, is subject to the engineer's approval before delivery of said materials onto the project. All materials are subject to inspection and possible rejection at any time prior to their incorporation in the Project. An approved source of supply remains approved only so long as the materials obtained therefrom are acceptable. Any approved material which has become mixed with or contaminated by disapproved or foreign materials, prior to use or installation, is subject to rejection, in whole or in part. The Commission shall not be responsible for the quality or quantity of materials produced at or developed from any source; when quality and quantity are shown at all it shall be an indication only, unless specifically stipulated otherwise. The engineer has the authority to reject all or any part of the materials at a source. If the contractor become delinquent in payments due the owner of any source of materials, and said owner duly and properly notifies The Commission of such circumstances, then such delinquent payments may be withheld from estimate payments due the contractor.

Whenever the "Available Surfacing Materials Report" shows the source to be "State Highway Commission Optioned", the materials from such source or sources will be available to the contractor at no cost or royalty unless specifically stated otherwise in the special provisions.

Materials shall, in general, be considered to come from or be prepared at three types of sources: (1) Source selected by the contractor; (2) Source indicated but not designated by The Commission; (3) Source designated by The Commission.

(B) **Source Selected by the Contractor.** The contractor shall be wholly and completely responsible for the quality and quantity of any and all materials supplied and furnished in such a case. He shall bear the complete expense of acquisition, development, production and incorporation in the Project of all necessary materials.

(C) **Source Indicated by Commission.** The Commission will indicate on maps, plans or otherwise, where certain materials (generally surfacing or other aggregates) are known to exist. The Commission will provide test data concerning quality and quantity but will make no guaranty in any respect as to quality and quantity of material produced therefrom. The Commission holds no title in such sources, generally, and therefore, has none to convey to the Contractor; however, there may be occasional cases wherein The Commission has obtained an

option on the use of a source of material and, under such a condition, the pertinent terms of the option shall be specified in the proposal form. The option may include the provision that the contractor shall pay the owner of the source of the material a specified amount (which normally will be approximately 20 percent of the optioned price of all of the material that is estimated will be used from that source on the construction of the Project). This payment shall be made by the contractor to the owner within 60 days after award of the contract; if not made within that time the amount shall be paid by The Commission to the owner and deducted from earnings of the contractor. The balance due the owner shall be paid within 30 days after the last of the material has been used. If the contractor elects to use any or all of such indicated sources, then the provisions set forth in Part (B) above shall prevail. The contractor may use any indicated source he chooses but it shall be his responsibility, and his alone, to produce satisfactory material therefrom.

(D) Source Designated by Commission. The Commission may, under certain circumstances, designate a source or sources of material which shall mean that the contractor is required, as a condition upon which he prepares his bid for the Project, and further shall be a condition of the Contract, to obtain materials for the Project from such designated source or sources. Materials obtained from such sources will be furnished, free of charge, to the contractor, including right of ingress, egress, and storage of materials and equipment thereon during the contract period; however, the contractor shall bear all expenses incurred in producing, and incorporating in the Project, satisfactory materials. If, during the course of production of materials, it is necessary that certain materials be rejected they shall be stockpiled on the site at a place stipulated by the engineer. The Commission retains the title to all rejects, screenings, or other by-products of the development of the site or the production of material used on the Project. If The Commission designates two or more sources of materials it reserves the right to decide the order or sequence and extent to which each shall be used. The Commission will assume the responsibility for the quality (with the express understanding that it is meant that it is possible and practicable to produce material meeting the specifications) and quantity of materials in the source or sources and if it becomes necessary to move to another site because specifications cannot be met (the engineer to be the sole judge thereof) or quantity is insufficient, The Commission will allow the contractor for actual moving expenses and loss of contract time incurred; that, if the haul of material from the source to the Project is increased or decreased by such circumstances, The Commission will increase or decrease the bid price for the material ten cents per ton, or fifteen cents per cubic yard, dependent on the unit at which the item was bid, for each mile (or fraction thereof to one-tenth mile) the materials must be hauled; however, if there is in the contract a bid price for haul of this type of material, that haul

price shall prevail. Should the contractor propose to produce material from another source, which has been determined by the engineer to be of equal or superior quality, then the cost to The Commission for said material, if approved, shall be decreased at the rate of ten cents per ton or fifteen cents per yard for each mile or fraction thereof of decrease in length of haul, dependent on the unit at which the item was bid: 1 allowance shall be made for any resultant increase in haul!

(E) Bituminous Materials. The engineer reserves the right to change or substitute the type and grade of bituminous material to be used, depending on seasonal or other conditions; and in case of such change or substitution, a change order shall be executed prior to the use of the materials. The basis of payment for the changed or substituted bituminous material shall be the unit bid price for the respective type and grade of bituminous material called for in the contract, plus or minus the difference in cost to the contractor at the refinery between the type and grade called for in the contract and the changed or substituted type and grade.

06.02 PLANT INSPECTION. If the volume, progress of the work and other considerations warrant, the engineer may undertake the inspection of materials at the sources of supply. Plant inspection, however, will not be undertaken until the engineer is assured of the cooperation and assistance of both the contractor and the material producer. The engineer shall have free entry at all times to such parts of the plant as concern the manufacture or production of materials ordered and the material producer shall furnish, free of charge, all reasonable facilities to assist in determining whether the material furnished meets with the requirements of the specifications. The engineer assumes no obligation to make the inspection of materials at the source of supply and the responsibility of securing satisfactory materials rests entirely with the contractor. Attention is directed to Article 20.02(A) concerning the sampling and testing of surfacing aggregates.

The engineer reserves the right to retest all materials which have been tested and accepted at the source of supply after the same have been delivered and to reject all materials which, when retested, do not meet the requirements of the specifications.

The contractor shall give sufficient notification of the placing of orders for materials to permit testing.

06.03 SAMPLES AND TESTS. Samples, as prescribed or required, shall be submitted by the inspector, contractor or producer for testing. Tests shall be made in accordance with the Standard Specifications for Methods of Sampling and Testing as adopted by the American Association of State Highway Officials insofar as covered therein. Test methods which are not covered in that publication shall conform to the Standard Specifications of the American Society for Testing Materials, or by such other recognized standard methods as may be specified

or described in the specifications or designated by the engineer. Where reference is made by serial designation to test methods or specifications of either the American Association of State Highway Officials' Standards or those of the American Society for Testing Materials, it is understood that the latest approved method or specification shall apply.

The contractor shall afford such facilities as the engineer may require for collecting and forwarding samples, and shall not make use of, or incorporate in the Project, any material represented by the samples until the tests have been made and the materials found to be acceptable in accordance with the requirements of the specifications. The contractor shall furnish, without charge, all samples required.

When required by the engineer or requested by the contractor, representative preliminary samples of the character and quantity prescribed shall be submitted for examination and shall be tested in accordance with the methods referred to herein. The acceptance of a preliminary sample shall not be construed as acceptance of materials from the same source delivered later, unless such materials are found to be of equal or of better quality than the preliminary sample. Only the materials actually delivered for incorporation in the Project will be considered and their acceptance or rejection will be based solely on the results of the tests prescribed in the specifications.

06.04 STORAGE. Materials shall be stored so as to insure the preservation of their quality and fitness for the work. Stored materials shall be located so as to facilitate prompt inspection.

That portion of the Highway not required for public travel, may be used for storage purposes and for the placing of the contractor's plant and equipment, but any additional space required shall be provided by the contractor at his expense. Where more than one contractor is engaged upon work on the same project or section of the project, or upon work in the same vicinity, the use of the Highway for storage purposes, for placing the contractor's plants and equipment, or for camp purposes, shall be contingent upon such use not interfering with the construction operations of other contractors, and if ordered by the engineer, the contractor shall promptly move his stored materials, plant, equipment and camp to a location where it will not interfere with any construction operation.

06.05 DEFECTIVE MATERIALS. Materials not conforming to requirements shall be rejected and removed from the work and shall be replaced by acceptable materials and in an acceptable manner by the contractor and at his expense. The engineer may remove defective materials and charge the expense thereof against the contractor. Reference is here made to Article 05.09.

SECTION 7

LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

07.01 LAWS TO BE OBSERVED. The contractor shall, at all times, observe and comply with all Federal and State Laws, including fuel tax laws, and local by-laws, ordinances and regulations in any manner affecting the conduct of The Work, and shall indemnify and save harmless the State and all of its officers, agents and servants against any claim or liability arising from or based on the violation of any such law, by-law, ordinance, regulation, order or decree, whether by himself or his employees.

In carrying out work within or adjacent to a National Forest, the contractor shall comply with all of the regulations of the Department of Agriculture governing the protection of forests and the carrying out of work within National Forests, and shall observe all Federal and State Sanitary Laws and regulations with respect to the performance of work in forest areas. He shall keep the areas in an orderly condition, dispose of all refuse, obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks and other structures in accordance with the requirements of the Forest Supervisor.

The contractor shall take all reasonable precaution to prevent and suppress forest fires, and shall require his employees and subcontractors, both independently and at the request of Forest officers, to do all reasonably within their power to prevent and suppress, and to assist in preventing and suppressing forest fires, and to make every possible effort to notify a Forest officer at the earliest possible moment of the location and extent of any fire seen by them and to extinguish the same if nearby and practicable.

It shall be the responsibility of the contractor to prevent the escape of fires set in the course of construction of the Project, and to extinguish such as may escape, without expense to the State of Montana and the United States. Strict compliance with the laws governing burning operations during the designated fire season will be required at all times.

When the area through which the Highway is being constructed lies within the jurisdiction of the Forest Service, or of a duly authorized State or local Fire Protection Agency, for the purpose of fighting fires in the vicinity of this Project which are not caused by the contractor, the contractor, when requested by the Forest Officer, shall place his employees temporarily at the disposal of the Forest officer; with the understanding, however, that payment to such employees for such services will be made by the United States or other agency

concerned at not less than the current rate for such services established by the Forest Service in the area concerned, and any employees furnished will be relieved from fire fighting as soon as the Forest officer in charge finds that it is practicable to employ other help adequate for the protection of the area. If the Forest officer is on the ground, the fighting of the fire will be under his direction.

During the period from April 1st to November 15th of each year, spark arresters satisfactory to the Forest Supervisor in charge of the area concerned shall be maintained on all steam and gas driven machinery used on the Project and on all flues at construction camps.

The contractor shall fully repair all damage, caused by his equipment, other than ordinary wear and tear, to roads and trails and any other improvements of the United States in the National Forests.

07.02 PERMITS AND LICENSES. The contractor shall procure all permits and licenses, pay all charges and fees, and give all notices necessary and incidental to the due and lawful prosecution of The Work, except that nothing herein contained shall be construed as requiring the contractor to secure right-of-way for the road proposed for improvement.

07.03 PATENTED DEVICES, MATERIALS AND PROCESSES. The Commission assumes the responsibility of defending any and all suits brought for the infringement of any patent claimed to be infringed by the design, or general type of structure provided for in plans furnished the contractor by The Commission, and to hold the contractor harmless on account of such suits or claims for royalty.

The contractor assumes the responsibility of defending any and all suits brought for the infringement of any patent claimed to be infringed in any method, process, material or machinery which he may use in the execution of The Work.

The contractor must assume all responsibility for plans submitted by him for the use of the engineer and shall hold The Commission harmless from any suits, royalty or damage on account of the infringement of any patents by said plans.

07.04 RESTORATION OF SURFACES OPENED BY PERMIT. Any individual, firm or corporation wishing to make an opening in the Highway must secure a permit from, and will be required to deposit security with, The Commission in a suitable amount to cover the cost of making necessary repairs and the contractor shall not allow any person or persons to make an opening unless duly authorized by the engineer. Until the work performed under the contract has been accepted by the engineer the contractor shall make all necessary repairs, within the time indicated in writing by the engineer and in an acceptable manner, at any point or points in the roadway where any opening has been made by authority of the engi-

neer. Such repair work will be paid for as "Extra Work," as indicated in the specifications and said work shall be subject to the same conditions as The Work regularly performed under this contract.

07.05 FEDERAL PARTICIPATION. The attention of the contractor is directed to the provision of the Federal Highway Acts and amendments thereto. When the United States Government is to pay a portion of the cost of construction, the Acts of Congress mentioned herein provide that the construction work in each State shall be done in accordance with its laws and under the direct supervision of the engineer, subject to the inspection and approval of the proper Federal authority and in accordance with the rules and regulations made pursuant thereto.

The construction work shall be subject to inspection, at all times, and approved by the Department of Commerce, Bureau of Public Roads, or authorized agents thereof, and shall be performed in accordance with the laws of the State of Montana, and the rules and regulations of the Secretary of Commerce, made pursuant to that certain Act of Congress approved July 11, 1916 (Title 23, United States Code), entitled "An act to provide that the United States shall aid the State in the construction of rural post roads, and for other purposes," and all Acts of The Congress supplementary and amendatory thereto. Such inspection will in no sense make the Federal Government a party to this contract and will in no way interfere with the rights of either party. If required by the special provisions, all Federal Labor Laws shall be complied with and the contractor shall make all payroll records available to Federal inspection upon request.

07.06 SANITARY PROVISIONS. The contractor shall provide and maintain, in a neat and sanitary condition, such accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the State Board of Health or of other bodies or tribunals having competent jurisdiction. He shall commit no public nuisance.

07.07 PUBLIC CONVENIENCE AND SAFETY. The contractor shall in all respects comply with the Code of Minimum Safety Standards for the Construction Industry adopted July 1, 1957 by the Industrial Accident Board of Montana, and with all statutory provisions supplementary or amendatory thereto, pursuant to the authority granted by the Workmen's Compensation Act, Title 92, Revised Codes of Montana 1947, as amended, for the protection of the health and safety of employees on the project.

The contractor shall at all times so conduct his work as to insure, in the greatest possible degree, the uninterrupted convenience and safety of the traffic and the public in the vicinity of the work. No road shall be closed to the public except by

the express permission of the engineer. For additional instructions refer to Article 04.05, "Construction and Maintenance of Detours."

07.08 CONSTRUCTION SIGNS AND SIGNING. The contractor shall furnish, construct, erect and maintain all signs required by the specifications and standard drawings in providing the proper protection and direction of the traveling public. Reference is made to standard drawings wherein the first two digits of the drawing number is "07-". These drawings provide instructions and examples. No work shall commence until the project has been adequately signed and approved by the engineer. Signs conforming to the latest edition of the "Manual on Uniform Traffic Control Devices for Street and Highways," as published by the U. S. Department of Commerce, shall be used as much as is practicable.

Such facilities as red lights, lanterns, flares, artificial lighting and the like shall be operated from sunset to sunrise when necessary. Approved types of flashing signals may be required as occasion demands. Flagmen shall be used to the extent necessary to protect the public.

No speed limits shall be established by the contractor unless authorized by the engineer. Any limits so established shall be for a temporary period only, and shall be removed at the direction of the engineer.

Upon completion and acceptance of the work, all signs shall be removed. The salvaged signs shall remain the property of the contractor, excepting those furnished by the State.

The erection and maintenance of adequate signs and signing shall be considered a public responsibility and no direct payment therefor shall be made to the contractor.

07.09 USE OF EXPLOSIVES. In the use and storage of explosives, the contractor shall use every precaution to prevent injury to persons and damage to property. Secure storage places shall be provided and all such places shall be clearly marked with warning signs. Only persons experienced in the handling of explosives shall be allowed to use them on the Project, and no shot shall be fired until warning has been sounded and all persons removed from the radius of danger. The number or intensity of charges shall be reduced whenever directed.

In the handling and storage of explosives, the contractor must comply with all Federal, State and local laws and the State will in no way be responsible for any non-compliance therewith or for damages to property or injury to persons resulting from accidental or premature explosions or from any damage attributable to the use of such explosives.

07.10 PRESERVATION AND RESTORATION OF PROPERTY, TREES, MONUMENTS, ETC. The contractor shall be responsible for the proper preservation of all public and pri-

vate property, monuments, etc., along and adjacent to the roadway. He shall use suitable precautions to prevent damage to pipes, conduits and other underground structures, and shall protect from disturbance or damage all land monuments and property marks until an authorized agent has witnessed or otherwise referenced their location and he shall not remove them until directed. The contractor shall not wilfully or maliciously injure or destroy shade trees or shrubs and he shall not remove or cut them without proper authority. He also shall use particular caution to prevent damage to existing structures and adjacent roadway surfaces which are required to be used in the execution of the contract.

The contractor shall be solely responsible for any trespass upon adjacent property or injury thereto, resulting from or in connection with his operations. He shall be liable for any claims that may be made on account of the falling of trees or the deposit of debris of any kind upon private property.

The contractor shall restore, replace or otherwise make good the loss or damage to the above described property, or upon notice from the engineer, may cause such restoration, replacement or indemnification and charge same against moneys due or to become due the contractor. The criterion for the repair or replacement of damaged structures or road surfaces is the condition of the structures or road surfaces at the time of start of work by the contractor.

07.11 RESPONSIBILITY FOR DAMAGE CLAIMS. **(A) General.** The contractor shall save and keep harmless the State of Montana and any county, city or town thereof against and from all losses to it from any causes whatever growing out of the prosecution of The Work. The insurance policies carried by the contractor shall be endorsed to the effect that no policy shall be cancelled, altered, amended or coverage reduced without the giving of not less than thirty (30) days' written notice by the Insurance Company to the insured and The Commission. The required insurance shall be kept in full force and effect until all work required to be performed shall have been satisfactorily completed and accepted in accordance with the terms of the contract. All insurance policies issued in connection with the contract must be countersigned by a Montana Resident Agent.

(B) Insurance on All Contracts. The contractor shall carry public liability and property damage insurance to indemnify the public for injuries or damages sustained by reason of the carrying on of The Work.

The public liability insurance shall be in the amount of at least fifty thousand (\$50,000) dollars for one person and a total of one hundred thousand (\$100,000) dollars for one occurrence. The property damage shall be in the amount of at least twenty-five thousand (\$25,000) dollars for one occurrence and fifty thousand (\$50,000) dollars in the aggregate. Work shall not be started until the contractor has submitted evidence to The Commission that he has taken out adequate insurance.

(C) Insurance Involving Railroads and Railways. On contracts for railroad grade separation structures and on contracts where the Highway encroaches upon railroad right-of-way, the contractor shall furnish insurance in the amount and kind set forth by Article 07.16 or by the special provisions.

07.12 OPENING OF SECTION OF HIGHWAY TO TRAFFIC. Whenever, in the opinion of the engineer, any roadway, or portion thereof, is in acceptable condition for travel and is required for the convenience of the public, it may be opened to traffic as directed and such opening shall not be held to be in any way an acceptance of the roadway, or any part of it, or as a waiver of any of the provisions of the contract. Necessary repairs or renewals made on any such section of the roadway so opened, due to defective materials or work or to cause other than ordinary wear and tear, pending completion and acceptance of the roadway, shall be covered by Article 07.13.

If such roadway or portion thereof shall have been finished previously, in a manner acceptable to the engineer, the contractor shall be relieved of the maintenance thereof; but if it has not been previously so finished, it shall be maintained in a serviceable condition by the contractor, at his own expense, until such time as it is finished in an acceptable manner.

The acceptance of any portion or portions of the roadway prior to the acceptance of The Work as a whole shall be understood to be an acceptance only insofar as it relieves the contractor of the maintenance of such portion or portions. It will not entitle him to payment of any part of the retained percentage and it will not relieve him from responsibility for defective workmanship or materials.

In the case of a contract for the placing of a surface course or courses upon a grade previously constructed under a separate contract, the contractor shall be required to maintain the subgrade ahead of other operations covering the preparation of the subgrade.

07.13 CONTRACTORS RESPONSIBILITY FOR WORK. (A) Until its acceptance by the engineer, the improvement shall be under the care and charge of the contractor, and he shall be responsible for and shall repair and make good any injury or damage to the improvement or to any part thereof from any cause whatsoever; except that the contractor will not be held responsible for injury or damage to the improvement or any part thereof when, in the opinion of the engineer, such damage is not the result of careless, negligent or dilatory work on the part of the contractor, but is the result of unforeseen natural causes beyond the control of the contractor, such as violent storms, cloudbursts and floods. The judgment of the engineer in this matter shall be final and binding upon both parties to the contract. When a contractor has, through dilatory methods and other causes within his control, exceeded his contract time unjustifiably, and has, therefore, been denied an

extension of his contract time, the saving clause in the next preceding sentence shall not apply, but he shall be responsible for all damage of every nature.

(B) The above saving clause shall not apply to bridge contracts. The contractor, in submitting proposals for such work, must be governed by his own judgment as to probable weather and stream conditions and the actual resulting conditions will never be considered as unforeseen, but any loss or damage of any nature prior to acceptance of the improvement by the engineer shall be the responsibility of the contractor.

07.14 NO WAIVER OF LEGAL RIGHT. The Commission or the engineer shall not be precluded or estopped by any measurements, estimate or certificate made or given by them, or by any agent or employee of The Commission, under any provision or provisions of the contract, at any time, either before or after the completion and acceptance of The Work and payment therefor pursuant to any measurement, estimate or certificate, from showing the true and correct amount and character of the work performed and materials furnished by the contractor, or from showing, at any time, that any such measurement, estimate, or certificate is untrue or incorrectly made in any particular, or that the work or materials, or any part thereof do not conform in fact to the provisions of the contract. The engineer shall have the right to reject the whole or any part of the aforesaid work or materials, should the said measurement, estimates, certificate of payment be found, or be known to be, inconsistent with the terms of the contract or otherwise improperly given. The Commission shall not be precluded and estopped, notwithstanding any such measurement, estimate, certificate and payment in accordance therewith, from demanding and recovering from the contractor and his surety such damage as it may sustain by reason of his failure to comply with the terms and provision of the contract. Neither acceptance by The Commission, the engineer or any agent or employee of the Commission, nor any certificate by The Commission for payment of money, nor any payment for, nor acceptance of the whole or any part of The Work by The Commission or engineer, nor any extension of time nor any possession taken by The Commission or its employees, shall operate as a waiver of any portion of the contract or of any power herein reserved by The Commission, or any right to damages herein provided, nor shall any waiver of any breach of the contract be held to be a waiver of any other or subsequent breach.

07.15 FAMILIARITY WITH LAWS, ETC. The contractor is assumed to have made himself familiar with all Federal and State laws and local by-laws, ordinances and regulations which in any manner affect the work of those engaged or employed in The Work and no plea of misunderstanding will be considered on account of his ignorance thereof. If the bidder or contractor shall discover any provision in the contract which is contrary to or inconsistent with any such law, by-law, ordi-

nance or regulations he shall forthwith report it in writing to The Commission.

He shall be governed by and comply with statutes regulating the hours of employment on public works.

The contractor shall, in the performance of all work under the contract, give such preference to honorably discharged personnel of the Armed Forces of the United States and to disabled civilians as is provided for in the Revised Codes of Montana and amendments thereto.

07.16 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICE. (A) General. When and where the contractor's operations are adjacent to or in the same area as the properties, underground service facilities and other service lines, and particularly gas lines and cables carrying high voltage electrical current, belonging to public utility companies or other persons, or are adjacent to other property which might be damaged resulting in considerable repair expense, work shall not be commenced until all arrangements necessary for the protection thereof have been made. It shall be the responsibility of the contractor to contact the owners of said service and other facilities, or adjacent property, to determine what measures, if any, should be adopted to assure adequate protection of said facilities and to protect persons and property from any damage that might result if any of the service or other facilities were damaged. The contractor shall, having learned the locations of all such facilities and properties, mark and distinguish them so that his workmen may be governed accordingly. Extreme care shall be taken by the contractor in excavating and backfilling adjacent to any underground service lines or other underground facilities. When the contractor undertakes a project involving such circumstances he shall procure and carry insurance of a comprehensive type, coverage against underground damage and occurrences resulting therefrom, in addition to the insurance coverage required by the provisions of Article 07.11, "Responsibility for Damage Claims."

If it is necessary, in the prosecution of The Work, to interrupt existing surface drainage, sewers, or underdrainage, temporary drainage facilities shall be provided and maintained at the contractor's expense until permanent drainage facilities are completed. The contractor shall be responsible for, and shall take all necessary precautions to protect and preserve any and all existing tile drains, sewers, or other sub-surface drains, conduits and other underground structures or parts thereof, which may be affected by the operations in the contract, and which in the opinion of the engineer may be properly continued in use without any change. The contractor shall, at his own expense, satisfactorily repair all damage to such facilities or structures which may result from any of his operations or from his negligence during the period the contract is in force. The contractor and his surety shall be solely and directly re-

sponsible to the owners and operators of such properties for any damage, injury, expense, loss, inconvenience or delay, or for any suits, actions, or claims of any character brought on account of any injuries or damages which may result from the carrying out of the work to be done under any contract and, if required by The Commission, he and his subcontractors shall furnish Protective Public Liability and Property Damage insurance to each corporation, company, partnership, or individual owning or operating any of the properties affected, in guarantee of this responsibility.

(B) Work Near Railroads. In order to cause a minimum of danger to railway traffic and to comply with the railway company's requirements whenever, during the construction, operations must be conducted in proximity to the tracks of the railway company, the said operations shall be performed in such a manner as will not cause injury to persons or damage to the property of the railway company. The contractor shall give the railway company sufficient advance notice before such operations are commenced so that the railway company may provide flagmen or other representatives to protect the railway company's properties. The railway company will furnish the flagging service for the safe operation of their trains with their own forces and under their own rules and labor regulations and the contractor shall reimburse the railway company direct for the cost of such service, if any. All costs to the contractor for this flagging or other service will not be paid for directly, but it will be considered as subsidiary work pertaining to and absorbed in the various items of the contract. All expenses incurred by this temporary protection shall be repaid the owner of the utility by the contractor. No separate payment will be made for these items, as it will be considered subsidiary work pertaining to the various items of the contract.

The contractor and any of his subcontractors shall, for work at railroad crossings or work within railroad right of way, provide and carry Public Liability Insurance in an amount not less than two hundred fifty thousand dollars (\$250,000) for one person and five hundred thousand dollars (\$500,000) for one occurrence. Property damage insurance shall be in an amount not less than two hundred fifty thousand dollars (\$250,000) for one occurrence and five hundred thousand dollars (\$500,000) in the aggregate.

Whenever the special provisions call for additional coverages, they shall be provided as specified.

Copies of the policy form representative of the type of insurance required in conjunction with work on or near railroad property, are not attached hereto; they are available from the Office Engineer, Montana Highway Department, upon request. It must be specifically understood that the insurance requirements to comply with the above provision will be executed on the form stipulated, or its equivalent, and will be included and made part of the contract.

07.17 RIGHT-OF-WAY. All right-of-way for the roadway shall be provided by The Commission without cost to the contractor. All right-of-way may not have been obtained at the time when the bids are opened and the proposal considered, and in that case the award will not be made until the entire right-of-way has been obtained. The submission of a bid will be construed as an acceptance of this condition by the bidder, and no claim for damage or loss of anticipated profits on account of unavoidable delay in securing right-of-way will be considered by The Commission. If the contract is materially delayed because of right-of-way difficulties, due consideration will be given by The Commission in extending the contract time to make proper allowance therefor.

07.18 SMOKE AND DUST CONTROL. Whenever a hot-mix paving plant, aggregate crusher or similar operation is to be conducted, the contractor shall acquaint himself with all local conditions, city, county and state laws pertinent to air pollution before commencing his operations. It is possible that legal action may be instituted against the contractor to force him to conduct his operation in a dust and smoke free manner. The contractor should be prepared to operate in a manner satisfactory to a restraining court. This may mean employing adequate dust filters and smoke collectors or by any other means meeting the existing requirements. No additional payment will be made to the contractor for the use, installation or disruption of work or loss of time occasioned by any actions for dust or smoke control or for any other related reasons.

07.19 MAINTENANCE OF IRRIGATION WATER. Whenever, during the course of construction, it becomes necessary that irrigation water be made available for crops the various structures, boxes, channel changes and culverts which are affected, or are related to irrigation, shall be constructed or moved in such manner as to maintain sufficient flow of irrigation water.

The contractor will not be permitted to shut off irrigation water in any irrigation ditch without first consulting the water master or owner of the ditch and securing written approval for the period during which water may be shut off in each and every irrigation ditch.

07.20 RESTRICTED LOAD LIMIT FOR CONSTRUCTION EQUIPMENT. The contractor shall use due caution in connection with the bridge or bridges either adjacent to or on the Project and roadways adjacent to the Project so that all equipment and loads utilizing the same shall be strictly governed by the existing laws relating to size and weight of motor vehicles, Revised Codes of Montana, 1947, and amendments thereto.

07.21 STATE CONTROLLED SOURCES OF MATERIALS. It is hereby agreed that the State, its contractors, agents and employees, together with their machinery and equipment shall

take the necessary precautionary measures to preclude the straying of livestock into or out of any designated State controlled source of materials.

It is also agreed that it shall be the contractor's obligation to respect and protect all irrigation facilities and that any damage resulting from his operations shall be promptly repaired or replaced to the landowners' satisfaction.

07.22 PAYMENT OF BILLS AND OBLIGATIONS. The contractor shall promptly and truly pay all laborers, mechanics, subcontractors, suppliers and others who perform work or furnish materials and provender under the contract, and all persons who shall supply him and any subcontractors with provisions, provender, supplies or any commodity for the prosecution and completion of The Work; nor shall the contractor permit any lien or claim to be filed or prosecuted against the State of Montana, or any officer, agent or employee thereof for or on account of any labor or material furnished.

SECTION 8 PROSECUTION AND PROGRESS

08.01 ASSIGNMENT OR SUBLetting OF CONTRACT. (A)
Assignment of Contract. The contractor shall not make a blanket assignment of his earnings, transfer, convey or otherwise dispose of his right, title or interest therein to any other person, firm or corporation without the written consent of the Commission.

The Commission will not recognize nor accept an advance "blanket" assignment by the contractor to any bank or other third party under the provisions of which all payments due, or to become due, the contractor are proposed to be paid direct to such third party rather than to the contractor. The Commission will recognize a request by the contractor to deposit payments to his credit in any stipulated bank.

(B) Subletting. The contractor shall perform with his own organization, and with the assistance of workmen under his immediate superintendence, work of a value not less than fifty (50) percent of the combined value of all items of work covered by the contract for such project; provided, however, that any work under the contract which will require highly specialized knowledge, craftsmanship or equipment not ordinarily available in contracting organizations qualified to bid on the project may be designated and shown in the advertised specifications as "Specialty Items" and the items so designated may be performed by subcontract without regard to the above limitation.

No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of The

Commission. Work under a subcontract shall not be started until the subcontract has been approved by the engineer. Requests for permission to sublet, assign or otherwise dispose of any portion of the contract shall be in writing and accompanied by a showing that the organization which will perform the work is particularly experienced and equipped for such work. The request also shall be accompanied by at least three executed and certified copies of the subcontract and a letter from the surety, directed to The Commission, consenting to the subcontract.

The responsibility for informing the subcontractor of provisions of the contract, including labor provisions and minimum wage rates, shall rest with the contractor. The contractor shall give assurance that the minimum wage for labor, as stated in his proposal, shall apply to labor performed on all work sublet, assigned or otherwise disposed of in any way.

When the project is a part of the Interstate system of highways, the following provision shall be included in the written subcontract form:

“The subcontractor agrees to comply with all of the labor provisions in accordance with the attached “B Addenda” and “C Supplement to B Addenda”.

All labor addenda and supplements, applicable to the project, shall be physically attached to and made a part of the subcontract.

Written consent to sublet, assign or otherwise dispose of any portion of the contract shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. All subcontractors shall be considered the agents of the contractor and the latter shall be responsible for all work and material furnished and any indebtedness incurred by such agent. If any subcontractor fails to perform his work in a satisfactory manner his subcontract may be terminated by the engineer.

(C) Equipment Rental. When it is contemplated that additional equipment, not owned or under a rental purchase agreement, will be used by the contractor or subcontractor, and such use is to be paid for on an equipment rental basis, notification in writing shall be submitted to the engineer, prior to use of the equipment. The contractor or subcontractor, as the case may be, shall include the operators of such equipment on their respective payrolls at a rate not less than the minimum wage rate as determined by the labor addenda and supplements thereto, applicable to the contract.

The contractor or subcontractor shall assume payment for and the reporting of all contractual diesel fuel obligations that may have been made a part of the contract.

08.02 CHARACTER OF WORKMEN AND EQUIPMENT. The contractor shall, at all times, employ sufficient labor and equip-

ment for prosecuting the several classes of work to full completion in the manner and time required by the contract.

All workmen must have sufficient skill and experience to perform properly the work assigned to them. All workmen engaged in special work or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform all work properly and satisfactorily.

All equipment which is proposed to be used on The Work shall be of sufficient size and in such mechanical condition as to meet the requirements of The Work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no injury to the roadway, adjacent property or other highways will result from its use. The engineer may order the removal and require replacement of any unsatisfactory equipment.

Any foreman or workman employed by the contractor or by any subcontractor who, in the opinion of the engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the engineer, be removed forthwith by the contractor or subcontractor employing such foreman or workman, and shall not be employed again in any portion of The Work without the approval of the engineer. If the contractor fails to remove such person or persons as required, or fails to furnish suitable and sufficient personnel for the proper prosecution of The Work, the engineer may withhold all estimates which are or may become due, or may suspend the work until the contractor has complied with such orders.

No rental, including depreciation, will be allowed for any publicly owned equipment used by the contractor in the performance of the contract or on a force account basis unless authorized in writing by the engineer.

08.03 LIMITATIONS OF OPERATIONS. The contractor shall not open up additional work to the prejudice or delay of work already started, nor shall he inconvenience traffic more than is necessary as determined by the engineer. At no time during the prosecution of The Work shall more than two miles of roadway be under construction or obstructed to traffic without permission of the engineer. The final shaping of roadway ditches and borrow pits, the final finishing of earth graded roads and the fine grading of subgrade and shoulders shall follow the rough grading as closely as possible. If forward grading operations are unduly extended beyond finishing operations, they shall be suspended until all feasible finishing operations have been completed. Unless written permission is obtained from the engineer, placing of any surface course will not be permitted unless the contractor shall have at least one mile of completely finished grade in advance of the placing of such surface course.

The contractor shall begin work at such points as the engineer may direct and shall thereafter prosecute The Work

at such points and in such order as may be prescribed from time to time by the engineer.

08.04 CONTRACT TIME DETERMINATION. **(A) Contract Time.** Time allowed for performance of The Work, furnishing materials and completion of the contract will be determined by either the "Calendar Date" or the "Calendar Day" provision. The specific method for determining contract time will be stipulated in the proposal form and in the contract.

The calendar date method will determine the allowable time for performance of the contract by requiring that its completion be not later than a specified calendar date. Supplemental requirements of the method are described under Article 08.05—Calendar Date.

The calendar day method will specify the number of calendar days within which contract performance shall be completed. Supplemental requirements of the method are described under Article 08.06—Calendar Day.

(B) Filing Insurance. Within ten days following the date of the proposal acceptance, the contractor shall file with The Commission the name of the liability insurance underwriter together with the amount of insurance coverage posted for the contract. The contractor will not be permitted, under any circumstances, to begin work without first having filed this information.

(C) Contract Execution. Payment will not be made for any work performed or for any materials delivered prior to execution of the contract by the contractor.

08.05 CONTRACT TIME — CALENDAR DATE METHOD. When the proposal form and contract provide the completion of work be accomplished by a designated calendar date—e.g. September 15—then this Article shall apply as pertains to contract time and Article 08.06 shall not apply.

The contractor shall complete The Work within the time limit specified, and elapsed time will be computed in calendar days. Requests for extension of contract time will be considered by The Commission only when it is clearly shown that, by a reasonable and possible increase in force and equipment, the contractor cannot complete The Work within the time agreed upon. In planning his organization, the contractor must make allowance for lost time due to unfavorable weather and other conditions and must provide such force of men and equipment as may reasonably be expected to complete The Work within the time specified.

If satisfactory completion of the contract shall require extra or additional work the time allowed for performance shall be increased in the same ratio that the total cost of the extra or additional work shall bear to the total cost in the proposal form.

If the contractor finds it impossible to complete The Work on or before the time for completion specified in the contract he may, not less than ten days prior to said date, make written request to The Commission for an extension of time for completion. He shall set forth fully therein the reasons which he believes justify the consideration of his request. If The Commission finds that The Work was delayed because of conditions beyond the control of the contractor, it may grant such an extension of time for completion as appears reasonable and proper.

The contractor shall not be assessed with liquidated damages nor the cost of engineering and inspection during any delay beyond the contract completion date caused by delay in awarding the contract, by inability to secure sufficient labor, by failure of the State to obtain right-of-way, by acts of God or the public enemy, acts of the State, fire, floods, epidemics, quarantine restrictions, strikes, boycotts, freight embargoes, or delays of subcontractors due to such causes; provided, that the contractor shall notify the engineer in writing of the causes of delay within ten days from the beginning of any such delay, and the engineer shall ascertain the facts and the extent of the delay, and his findings of the facts thereon shall be final and conclusive.

The Commission will consider a request by the contractor for extension of time of completion of the contract on account of strikes, inability to secure sufficient laborers, time lost through delay in awarding the contract, or because of other unfavorable conditions clearly beyond the control of the contractor.

08.06 CONTRACT TIME—CALENDAR DAY METHOD. When the proposal form and contract provide that completion of work be accomplished within a designated number of calendar days—e.g. 250 calendar days—then this Article shall apply and Article 08.05 shall not apply.

The contract time for performance of The Work, furnishing of materials and construction of the Project in its entirety shall be the number of calendar days set forth on the proposal form and in the contract, subject to possible extensions as specified elsewhere in this provision. A calendar day will be considered as a twenty-four (24) hour calendar date.

Upon written notice to the contractor of contract proposal acceptance by The Commission, the contractor is authorized to order required materials and prepare to begin The Work contemplated by the contract. Normally, the notice of proposal acceptance will be issued the day following submittal of the contract proposal to The Commission.

At the end of the ten day period following the date of the notice of said proposal acceptance the contractor, normally, will be forwarded Notice to Proceed with Work. Assessment against the time allotted for performance of the contract shall

begin ten days following the date of notice from the engineer to proceed with work. Should circumstances, such as delayed materials, delivery or seasonal weather limitations distinctly not within control of the contractor, exist which would prevent completion of The Work within the time allotted, issuance of the "Notice to Proceed" may be withheld until such time as the circumstances in question have become normal or practical to the start of work.

No payment shall be made for any work performed or for any materials delivered under the contract prior to the date of execution of the contract by the contractor.

The contractor shall begin The Work contemplated by the contract on or before the date provided for and shall prosecute The Work continuously and with diligence to completion except when it is impossible to do so for reasons distinctly beyond his control. If the contractor desires to begin work prior to the effective date of the "Notice to Proceed", he shall be permitted to do so, provided that he has complied with all insurance requirements and that the physical conditions of the Project are satisfactory.

The number of calendar days allowed for performance of The Work contemplated by the contract is based on the quantities in the proposal form. If satisfactory fulfillment of the contract shall require the performance of extra or additional work, the time allowed for performance shall be increased in the same ratio that the total cost of the extra or additional work actually bears to the total cost in the proposal form.

Should it develop, either prior to the actual start of work or during active construction of the Project, the delivery of commercial materials ordered for incorporation into the Project is delayed in such manner as to retard scheduled starting or progress, a time credit to act as an extension may be considered.

The credit will be considered only upon written application of the contractor within ten days following occurrence of the delay and shall be accompanied by detailed data from the materials suppliers and allied services. Applications for time extension on this basis will not be considered when the materials and services can be obtained from other commercial sources of supply.

08.07 PROSECUTION, SUSPENSION AND RESUMPTION OF WORK. (A) **Either Method of Time Determination.** It is agreed and understood that the contractor will prosecute The Work contemplated under the contract with adequate equipment, labor and material and will carry on The Work a sufficient number of hours and shifts each day on a schedule which will insure completion of the contract within the time specified.

The contractor shall notify the engineer, in writing, five days in advance of the date he expects to start work and when he expects to begin important features of construction.

Operations will not be permitted at any time, other than daylight, on any class of work without written consent of the engineer. Permission to perform night work may be rescinded by the engineer at any time when, in his opinion, satisfactory results are not being obtained. Work at night will not be permitted, under any circumstances, unless the contractor furnishes flood lighting on the operations of sufficient intensity to insure the same degree of accuracy and quality of workmanship as would be obtained by daylight. Lights on equipment employed in performance of The Work will not be accepted as satisfactory lighting.

The necessity of suspending and resuming work on any portion of the contract will be determined by the engineer. He shall have authority to suspend The Work, wholly or in part for such period or periods as he may consider necessary. He will give consideration to unsuitable weather or to such other conditions as are considered unfavorable for the suitable prosecution or protection of The Work, or for such time as is necessary through failure of the contractor to carry out orders given or to perform any or all provisions of the contract.

The contractor shall not suspend work under the contract without a written order by the engineer. Suspension of The Work ordered by the engineer shall not furnish grounds for claims by the contractor for damages or extra compensation for a period of work suspension. The question as to the necessity of discontinuing any portion of The Work for reason of unfavorable conditions shall be determined by and shall be at the authority of the engineer. Upon failure or negligence on the part of the contractor to carry out the order of the engineer to perform work under the contract in accordance with the provisions thereof, the engineer may suspend The Work for such period as he considers necessary. Time lost by reason of such failure or negligence or in replacing improper work or materials shall not furnish grounds to the contractor for claiming an extension of time or extra compensation and shall not release the contractor from any damages or liability for failure to complete work within the allotted contract time. The contractor shall take every precaution to prevent any damage or unreasonable deterioration of The Work during the time operations are closed down.

Should it become necessary to suspend work for an indefinite period, the contractor shall store all materials in such manner that they will not obstruct or impede the traveling public nor become damaged in any way. He shall take every precaution to prevent damage or deterioration of The Work performed, provide suitable drainage of the roadway by opening ditches, shoulder drains, etc., and undertake any other precautions the engineer may direct. The contractor shall not suspend work under the contract without a written order from the engineer.

Suspensions involving cessation of work on all items, except minor construction not affected or connected with the

cause of suspension, shall be considered as a total suspension. Time spent on work of an emergency nature ordered by the engineer for the convenience of public traffic or time spent on the production of materials for storage if performed during a period of total suspension will not be charged against contract time. Where all work is completed but deferment of final inspection and acceptance is necessary due to causes not within control of the contractor, and due solely to that cause, no time charge shall accrue against the contractor for such elapsed period.

If, for any reason, the contractor shall suspend operations during the construction life of the contract, without a written order from the engineer, he shall be responsible for and shall at his own expense furnish all work and materials required for satisfactory maintenance of the Project and its restoration accrued during the delayed period.

The contractor shall reimburse the State for all field project engineering charges accrued during the delaying period resulting from his actions in suspending operations. These charges shall be considered separate and apart from any liquidated damage assessment.

(B) Calendar Date Method. The contractor shall begin The Work to be performed under this contract within ten days after the execution of the contract therefor, except as herein provided. The Work shall be conducted in such a manner and with sufficient materials, equipment and labor as will insure its completion within the time set forth in the contract. If the contract is awarded at such season of the year as to make starting of work impracticable or impossible, work shall be started within ten days of receipt of written notice from the engineer stating that conditions are such as to permit starting of operations. Should the prosecution of work for any reason be discontinued by the contractor, with the consent of the engineer, he shall notify the engineer at least forty hours before again resuming operation.

(C) Calendar Day Method. It is agreed and understood that the contractor will attend The Work contemplated under the contract with adequate equipment and labor and will carry on The Work a sufficient number of hours and shifts each day on a schedule which will insure completion of the contract within the number of calendar days allotted.

The necessity of suspending and resuming work on any portion of the contract shall be determined by the engineer. If the engineer believes that unfavorable working conditions or unavoidable delay conditions exist, due to no fault of the contractor, which would warrant suspension of The Work he shall issue to the contractor a written order to suspend work. The order to suspend work shall show the detailed reason for suspension and also shall show the number of calendar days elapsed to date and the number of calendar days remaining in which to complete the contract. When conditions are again

favorable for prosecution of The Work, the engineer shall issue to the contractor a written order to resume work which shall show the number of calendar days remaining in which to complete the contract. The calendar days of suspended or shut-down period, in cases of this nature, shall not be charged against the time allowed for performance of the contract work. No time allowance will be granted as the result of a partial suspension of work. The contractor shall be liable and responsible for all necessary maintenance of the road under construction or any designated detours, either of which is subject to use of public traffic, during all shut-down periods excepting those of seasonal duration.

08.08 UNAVOIDABLE DELAYS. Assessment shall not be made against the time allowed for performance of The Work contemplated by the contract for delays not due to any fault or negligence of the contractor or delays in awarding the contract, acts of the State, acts of the Federal Government, acts of God, acts of the public enemy, fire, flood, epidemics, quarantine restrictions, National or regional labor strikes, boycotts, freight embargoes or, when in the judgment of the engineer, unfavorable weather of prolonged duration renders it impossible for the contractor to secure specified contract results.

An act of God is construed to mean an earthquake, flood or other catastrophic phenomenon of nature beyond the power of the contractor to foresee or for which to prepare a defense.

A rain, windstorm or other natural weather phenomena of normal intensity, based on past experience for the locality, shall not be construed as an act of God and no time credit will be granted for delays resulting therefrom except as covered by suspension and resumption orders as provided elsewhere in these provisions.

The Commission may, upon written notice from the contractor within ten days of the known existence of causes over which he has no control and which might delay the completion of said work, at its discretion, extend the period specified for the completion of said work and in such case the contractor shall become liable for liquidated damages for delays commencing on the date on which said extended period shall expire.

08.09 FAILURE TO COMPLETE THE CONTRACT ON TIME. It is understood and agreed that time is the essence of the contract and that The Work must be completed within the time specified in the proposal and contract. If the contractor fails to complete The Work within the time specified, or within any authorized extension thereof, and if The Commission does not terminate the right of the contractor to proceed, the contractor shall continue and complete The Work. Under such circumstances the actual damages for the delay will be impossible to determine and in lieu thereof the contractor shall pay to The Commission, as fixed and agreed, liquidated damages for such calendar days that The Work shall remain uncompleted beyond the specified completion date or exceed the

specified number of calendar days, as the case may be, the sum set forth in the following schedule. The contractor shall be liable for the payment of the amount thereof, which amount shall be deducted from the final payment due the contractor under the contract.

SCHEDULE OF LIQUIDATED DAMAGES

Proposal Total	Liquidated Damages
Less than \$10,000	\$ 20.00 per day
\$10,000 and less than \$25,000	\$ 30.00 per day
\$25,000 and less than \$50,000	\$ 50.00 per day
\$50,000 and less than \$100,000	\$ 60.00 per day
\$100,000 and less than \$200,000	\$ 70.00 per day
\$200,000 and less than \$300,000	\$ 80.00 per day
\$300,000 and less than \$500,000	\$100.00 per day
\$500,000 and over	\$200.00 per day

08.10 TERMINATION OF RIGHT TO PROCEED UNDER CONTRACT. If the contractor fails to comply with any of the requirements of the plans, standard specifications, supplemental specifications or special provisions, or any other instrument incorporated in the contract, or shall discontinue the prosecution of The Work, or if the contractor shall become insolvent or bankrupt, or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of six days, or shall make an assignment for the benefit of creditors, or from any other cause whatsoever shall not carry on The Work in an acceptable manner, the engineer shall, upon receipt of such information, give notice in writing to the contractor and his surety of such delay, neglect or default, specifying the same, and if the contractor within a period of three days after such notice shall not proceed in accordance therewith, then the State shall, upon written certification from the engineer of the fact of such delay, neglect or default and the contractor's failure to comply with such notice, have full power and authority, without violating the contract, to take the prosecution of The Work out of the hands of said contractor, to appropriate or use any or all materials and equipment on the ground as may be suitable and acceptable and may enter into an agreement with any other person or persons for the completion of said contract, according to the terms and provisions thereof, or use such other methods as it may deem expedient for the completion of said contract in the specified manner. All costs and charges incurred by the State, together with the costs of completing The Work under the contract, shall be deducted from any moneys due, or which

may become due, said contractor. In case the expense so incurred by the State shall be less than the sum which would have been payable under the contract, if it had been completed by said contractor, then the said contractor shall be entitled to receive the difference; and in case such expenses shall exceed the sum which would have been payable under the contract then the contractor and his surety shall be liable and shall pay to the State the amount of said excess.

08.11 TERMINATION OF CONTRACT BEFORE COMPLETION WITHOUT FAULT OF THE CONTRACTOR. The Commission shall have the right to terminate any contract at any stage of completion without fault of the contractor, when in the event of a national emergency or for other reasons beyond the control of The Commission, such termination becomes necessary to the best interest of the State, and written notice of such termination is given the contractor. Upon such termination, the contractor shall be entitled to the full amount of the estimate, including any retained percentage, for The Work actually done by him under the terms and conditions of the contract up to the date of service of the notice of termination. In addition, the contractor shall be reimbursed by The Commission for expenditures which, in the judgment of the engineer, are not otherwise compensated for and as are required in preparing for, moving to and from the job and for materials on hand. It is the general intent that an equitable settlement shall be made with the contractor.

Notice shall be considered to have been served upon the contractor when delivery to the person in charge of any office used by the contractor, the contractor's superintendent, or other authorized representative in charge of the job has been completed or such notice has been sent by registered mail to the contractor at his last known place of business.

08.12 TERMINATION OF CONTRACTOR'S RESPONSIBILITY. The contract shall be considered to have been completely fulfilled when all work has been completed and accepted by The Commission and the final estimate has been accepted by the contractor and paid. The contractor shall then be released from further obligation under the contract except as set forth in his contract bond.

SECTION 9

MEASUREMENT AND PAYMENT

09.01 MEASUREMENT OF QUANTITIES. The determination of quantities completed under the contract will be made by the engineer, based upon actual measurement of the work according to the United States standard measures. All lengths and distances shall be measured horizontally unless otherwise shown on the plans. In computing volumes, the method of average end areas will be used for excavation and embankment. The area of surfacing to be paid for will be only the actual area covered by the entire surfacing or paving material within the lines designated or given, except that no deduction will be made for fixtures, in the roadway or street, of nine square feet or less. Concrete and other similar structures will be measured, and the volumes will be computed, according to the neat lines shown on the plans or ordered by the engineer. Other quantities will be computed in units indicated in the proposal form according to well established engineering principles and no local rules or customs at variance therewith will be considered. When the proposal calls for payment on a ton basis the unit shall be the ton of 2,000 pounds.

09.02 SCOPE OF PAYMENTS. The contractor shall receive and accept the compensation as herein provided in full payment for all work contemplated and embraced under the contract; also for all loss, damage or expense of whatever character arising out of the nature of the work or the prosecution thereof. The payment of any current or final estimate, or of any retained percentage, shall in no way or in no degree prejudice or affect the obligation of the contractor to submit for final acceptance a completed improvement in accordance with the requirements of the plans, specifications, special provisions, and supplemental agreements.

09.03 ADVANCE PAYMENTS FOR MATERIALS. Allowance may be made, at the discretion of the engineer, on progress estimates for the net cost of any materials, which are not subject to deterioration, and which are intended to become a permanent part of the Project. Advance payment shall not be made unless requested by the contractor. All materials which are approved and accepted by the engineer for advance payment must be delivered and stored on the Project, or in another place approved by the engineer. Any advance for materials in storage shall be made only as a reimbursement for monies actually expended, either directly or indirectly. As a basis for determining the amount and value of the materials on hand, the contractor shall deliver to, the engineer, certified copies of such paid invoices, paid freight bills, or other information as the engineer may require. The materials must be stored in a manner satisfactory to the engineer, but neither the approval and acceptance of the materials to be stored nor approval of

the method of storage by the engineer shall relieve the contractor of the responsibility for the final quality of the materials as they are placed in The Work.

09.04 PAYMENT FOR EXCESS MATERIAL. When the contract provides that crushed cover aggregate shall be placed on the roadway it may not be practicable for the contractor to produce the exact amount required. The Commission will purchase unused crushed cover aggregate up to a maximum amount equivalent to the difference in the tonnage specified by the contract and the tonnage actually used on the roadway.

When the contract provides for a stockpile of "Type 'A' Crushed Top Surfacing" and the same material is used for "Cover Aggregate" then any approved excess shall be paid for at the contracted stockpile price with no allowance made for haul.

When the contract does not provide for a stockpile of "Type 'A' Crushed Top Surfacing" and that material is used for "Cover Aggregate" then the provisions of this Article shall apply except that the price to be paid the contractor for such excess material shall be seventy-five cents (\$0.75) per ton if the contract price is by the ton and one dollar and fifteen cents (\$1.15) per cubic yard if the contract price is by the cubic yard.

When the contract provides for "Crushed Cover Aggregate" in accordance with Section 27, The Commission will purchase any acceptable excess material in accordance with the following schedule per ton:

	Grade			
	1	2	3	4
Cover Material -----	\$1.50	\$1.75	\$2.00	\$2.25
Stone Chips -----	\$2.00	\$2.25	\$2.50	

Payment for haul from the crusher site, over the most practicable haul route as determined by the engineer, to the stockpile site will be allowed at the rate of ten (\$0.10) cents per ton mile for haul distance in excess of 2,000 feet. (e.g.—for a haul distance of 3,200 feet, haul will be paid for 1,200 feet). No haul payment will be allowed when the distance is less than 2,000 feet.

If the unit price bid for cover material or stone chips in place is less than the amount listed for the respective item, The Commission will compensate the contractor at his unit price bid.

Purchase of the excess crushed cover aggregate will be at the contractor's option. If the contractor does not elect to dispose of the material at the herein-scheduled prices, it shall

remain the contractor's property but it shall be removed from State premises, and The Commission will disclaim further responsibility in the matter.

The contractor will be required to pay to the owner of any state-optioned material source the royalty agreed upon between the state and the property owner for any materials used or disposed of by the contractor for purposes other than incorporation in the project or purchase by the state.

09.05 PAYMENT AND COMPENSATION FOR ALTERED QUANTITIES. When alterations in plans or quantities of work not requiring supplemental agreements as hereinbefore provided, are ordered and performed, the contractor shall accept payment in full at the contract unit prices for the actual quantities of work done. In no case of altered quantities will any allowance be made for any increased expenses, loss of expected reimbursements, or loss of anticipated profits suffered or claimed by the contractor resulting either directly from such alterations, or indirectly from unbalanced allocation among the contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursement therefor, or from any other cause. Quantities of Class "A" concrete and quantities of structure excavation will be increased, for bidding purposes, in the amounts (generally 5 percent for concrete, and 15 percent for excavation) shown on the plans. Roadway excavation quantities will be increased seven (7) percent, unless especially provided otherwise, above computed quantities in order to cover possible overruns. Only accepted quantities actually entering into the final construction will be eligible for payment.

09.06 EXTRA AND FORCE ACCOUNT WORK. Extra work, as hereinbefore described under Section 4, "Scope of Work," shall be paid for either at agreed unit prices under the provisions of a "Supplemental Agreement," or on a "Force Account" basis, as shall have been agreed by the engineer and contractor before starting said work.

(A) Supplemental Agreement. When it has been agreed to perform certain extra work not contemplated in the original proposal and contract on the basis of agreed prices, a "Supplemental Agreement" will be prepared. It shall describe, fully and completely, said extra work, including the approximate quantity as nearly as may be determined in advance of the performance of the work, and the agreed unit prices. This "Supplemental Agreement" shall be executed by both parties to the original contract, shall thereupon be considered a part of the contract and payment for the work included therein shall be for the actual quantity performed at the agreed unit prices set forth therein. Extra work provided for by a "Supplemental Agreement" shall not be started until after the execution of the said agreement.

(B) Force Account Work. Where extra work on a "Force Account Basis" has been ordered by the engineer, in writing,

as provided under Section 4, "Scope of Work," it shall be paid for in the following manner:

- (1) For all labor, teams and foremen in direct charge of the specific operation, the contractor shall receive actual direct payroll cost plus 15 percent.
- (2) For all materials used, the contractor shall receive the actual delivered cost of such materials as shown by original receipted bills, plus 10 percent.
- (3) For any machine-power tools or equipment, including fuel and lubricants, which it may be deemed necessary or desirable to use, the engineer shall allow the contractor a reasonable rental price, to be agreed upon in writing before such work is begun, for each and every hour or day that said tools or equipment are in use on such work and to which sum no percentage shall be added.
- (4) For Workmen's Compensation Insurance, Public Liability and Property Damage Insurance, and Premium on the Performance Bond, and such other expense as might be imposed on the contractor by Federal and State laws, the contractor shall receive the actual cost thereof chargeable to the force account work, to which no percentage shall be added. The contractor shall furnish satisfactory evidence of the rate or rates paid for insurance and bond.
- (5) The compensation as herein provided shall be received by the contractor as payment in full for extra work done on a "force account" basis, and shall include superintendence, use of tools and equipment for which no rental is allowed, and profit. The contractor's record of extra work done on a "force account" basis shall be checked by the inspector at the end of each day and a copy of these records, signed by both the inspector and the contractor's representative, forwarded to the engineer. All claims for extra work done on a "force account" basis shall be submitted on estimate forms furnished by The Commission, accompanied by the original Extra Work Order and receipted material and freight bills. Such claims shall be submitted to the engineer not later than the 10th day of the month following that in which the work was actually performed.

Payment for Extra Work will be made as provided for in these specifications.

09.07 OMITTED ITEMS. It is hereby provided that the engineer may order omitted from the contract items included in the original contract which may later be found unnecessary to the improvement, without thereby in any manner nullifying the contract or any of the other provisions thereof; provided, however, that when the contractor has paid for material or incurred other expense in relation to any such item, before the

elimination of same is ordered, he shall be reimbursed for his actual costs as evidenced by said invoices, paid time checks and other similar evidence which may be demanded by the engineer to fully support the cost statement of the contractor. In no case of this sort shall any allowance be made for anticipated profits.

09.08 UNAUTHORIZED WORK. Work done without lines or grades being given, work done beyond the lines or grades shown on the plans or as specified by contract documents, except as herein provided, or any extra work done without written authority from the engineer, will be considered as unauthorized and at the expense of the contractor and will not be measured or paid for. The contractor shall, in no event, incur any liability by reason of any verbal directions or instructions that he may receive from the engineer; nor shall the State be liable for any extra materials furnished or used, or for any extra work or labor done, unless said materials, work or labor are required by the contractor on written order from the engineer. Any such extra work or materials which may be done or furnished by the contractor, without such written order first being given, shall be at the contractor's own risk, cost and expense, and he shall make no claim for compensation for work or materials so done or furnished. Work so done may be ordered removed or replaced at the contractor's expense. In measuring quantities, no allowance will be made for excavation or embankment in excess of that required by sections shown on the plans unless such increase in quantity has been authorized in writing by the engineer.

09.09 PARTIAL PAYMENTS. The engineer shall make estimates, in writing, each working month of the materials in place complete and the amount of work performed, including "extra material and extra work" in accordance with the contract, during the preceding month and the value thereof at the unit prices contracted.

The Commission shall retain 10 percent of each monthly estimate until after completion of The Work; provided, however, that if the contractor is not delinquent in any contractual or other obligations related thereto, and progress is satisfactory, the retainage may be limited to 5 percent (to the nearest \$100.00 above) of the total amount of the contract.

The total amount of the estimate, less the amount retained, will be certified by The Commission to the State Board of Examiners for payment except when such balance amounts to less than \$500.00. In case the amount earned during any one month, less the amount retained, shall be less than \$500.00, no payment will be made except on the final estimate. All earned payments due the contractor shall be paid within thirty (30) days following the expiration of the estimate period.

If the total amount of the retained percentage is greatly in excess of the value of the uncompleted and unaccepted

portion of the contract The Commission may, upon written request by the contractor, approval of the engineer and consent of the surety, allow the contractor a portion of this suspended payment, provided that The Commission shall at all times retain an amount sufficient to enable the State to complete the unaccepted or uncompleted work in the contract and liquidate unsatisfied claims. Partial payments shall not be evidence of acceptance of unsatisfactory work or material.

09.10 ACCEPTANCE AND FINAL PAYMENT. Whenever the contractor shall have completed the work in accordance with the terms of the contract and shall have so notified the engineer in writing, the engineer will make final inspection of the work and upon completion of repairs, renewals or other work found to be necessary, if any, he will certify to completion and recommend to The Commission that final acceptance of the Project be made and such final acceptance will be made by The Commission at its next regular meeting after receipt of the certificate of completion and recommendation from the engineer. The engineer will arrange to make such final inspection within fifteen (15) days after the date of completion by the contractor. Upon acceptance of the completed contract by The Commission, the engineer will notify the contractor and his surety of the acceptance.

The Commission reserves the right to withhold final payment of monies earned under the contract until all fuel taxes owed to the State, due to operations under the contract, have been paid in full.

The statutory time, ninety (90) days, for filing claims against the contract bond shall date from the day of final acceptance of the Project by affirmative action of The Commission—see Sections 6-401 to 6-404, inclusive, Revised Codes of Montana, 1947, as amended.

The Commission reserves the right to withhold payment of the contractor's final estimate until any and all just claims filed with The Commission against the contract or bond have been settled. If there are no claims filed within the thirty day period following the formal acceptance of the Project by affirmative action of The Commission, payment of the final estimate will be made.

Also, should a just claim or claims be filed with The Commission against the contract or bond after the stipulated thirty day period has expired and the final estimate has not yet been paid, The Commission reserves the right to withhold said final payment until notice of satisfaction of such claim or claims has been received.

The engineer shall immediately notify the contractor and his surety of all claims filed against the contract or bond.

If at the end of the stipulated thirty day period, no just claims have been filed with The Commission against the con-

tract or bond, the engineer will request formal permission from the contractor's surety to pay the final estimate.

The payment of the final estimate by The Commission at the expiration of the stipulated thirty day period does not in any way relieve the contract bond of its responsibility for any unsatisfied claim or claims filed with The Commission during the remaining portion of the statutory period.

After notifying the contractor and his surety of Commission acceptance, the engineer will prepare the final estimate, including therein the amount and value of each class of work performed and including any "extra work" and "extra materials." Upon settlement of any claim or claims filed and expiration of the thirty (30) days estimate retaining period, whichever occurs first, or in the case of no claims filed, the engineer will transmit to the contractor a claim embodying the final estimate. Accomplishment of the affidavit on the final estimate claim by the contractor shall constitute full acceptance by him of the total amount shown as the entire amount due him under the contract.

Upon return by the contractor of the accomplished final estimate claim, it shall be certified by The Commission to the State Board of Examiners for payment and payment thereof shall constitute, together with previous partial payments, full satisfaction for the total amount due under the contract. Erroneous or overpayments made by previous and partial payments shall be subject to correction in the final estimate.

SECTION 10

CLEARANCE OF RIGHT-OF-WAY

SUBSECTION 10.00 CLEARING.

10.01 DESCRIPTION. "Clearing" shall consist of the removal and disposal of trees, stumps, brush, windfalls, logs, vegetation and other objectionable matter occurring within the clearing limits, as hereinafter defined, or which interfere with excavation, embankment or the designated clear vision areas.

10.02 CONSTRUCTION METHODS. All areas of the right-of-way so designated on the plans or shown in the proposal, and all areas between lines five (5) feet outside of the grading limits for cuts, channels, ditches, material sites, and sources and within neat lines of fill areas, shall be cleared. If slopes are to be rounded, the clearing area shall extend to the outside limits of the slope rounding. Unless specifically designated to be saved, all trees, stumps, brush, windfalls, logs and other objectionable matter occurring within clearing limits shall be cut off and disposed of as hereinafter provided. All stumps within the right-of-way limits and all trees, the stumps of which are not to be grubbed, shall be cut not more than the diameter of the stump, and in any instance not more than twelve (12) inches, above the ground.

Removal of live trees from within the area between the right-of-way lines and the clearing limits, as defined in the preceding paragraph, will not be required or permitted except as may be necessary to protect slopes or to add to the safety of the Highway. However, all dead trees and windfalls shall be removed and underbrush and debris shall be cleaned from the entire width of the right-of-way. All stumps shall be cut off as prescribed in the preceding paragraph. Cleaning up of windfalls shall include the disposal of any uprooted stumps.

Timber having commercial value shall be cut into logs in accordance with established logging practice. Any loss from breakage, due to unskilled or careless felling or handling, may be charged back against the contractor. Logs shall be decked along the Highway, free of cuts or fills, at points convenient for loading, and shall remain the property of the State. No National Forest timber may be cut or destroyed without first communicating with the National Forest Service officer responsible for the area concerned. All timber cut from the National Forest land shall remain the property of the United States, to be disposed of as the Forest Service officer may determine.

All trees shall be felled within the area to be cleared, and all brush, stumps, waste logs, limbs, tops, roots, duff, and other debris resulting from clearing, which is not of commercial value, shall be placed in piles and burned in such a manner as to be completely consumed. If the burning is to precede the construction operations the piles may be placed in the center

of the right-of-way; otherwise the piles should be placed in the most convenient place to the side of the right-of-way and beyond fill slopes, where they may be burned without damage to the surrounding forest cover. In no case will it be permissible merely to throw the refuse outside of the right-of-way or into streams or lakes. The material placed in piles shall be burned by the contractor, unless otherwise specified, at such time and in such manner as will prevent the fire from spreading to areas adjoining the right-of-way.

The contractor shall avoid, as far as practicable, injury to shrubbery, vines, plants, grasses and other vegetation growing on areas outside of the slope limits of excavation and embankment. The dragging, piling and burning of clearing debris, and work which may be injurious to vegetation, shall, insofar as is practicable, be confined to areas which carry no vegetation or which will necessarily be covered by embankments or disturbed by excavations. The provisions of this Article are not to be construed as relieving the contractor of the clearing of dead vegetation, logs, stumps, limbs, sticks and other undesirable matter occurring on areas where live shrubbery, brush, trees, and other desirable vegetation are to be left in place.

All timber, except that designated as having commercial value, and all slash and debris resulting from clearing and construction operations shall be disposed of either by piling and burning or by any other method agreeable to the Forest Service officer who shall see to its removal from the area. Piles made for burning at a later date shall be located in places where burning will not injure uncut green timber growth of any size, and provided further that any burning undertaken shall be done only at such times, in such manner, and under such conditions or arrangements as may be prescribed beforehand by the Forest Service officer.

10.03 METHOD OF MEASUREMENT. The boundaries of the area to be cleared will be established by the engineer by the use of stakes, lath, flags or other satisfactory means. Areas between the right-of-way lines and the clearing limits, which require cleaning up and the disposal of underbrush, dead timber, logs, stumps, windfalls and other debris, shall be cleared by the contractor as a part of his obligations under this bid item.

When "Clearing" has been bid at a unit price per acre, the acreage to be measured and paid for will be the number of acres, computed to the nearest hundredth, actually cleared and accepted as complete. Appropriate deductions will be made for cleared acreage of existing right-of-way coincident with the right-of-way of the project under construction. Acreage will be determined from horizontal measurements.

When "Clearing" has been bid at a lump sum price the item shall include all necessary "clearing," as defined and described in this subsection, involved in the satisfactory completion of the Project.

10.04 BASIS OF PAYMENT. If there is some "Clearing" work that should be performed, on the Project, and there is no "Clearing Item" in the proposal then it is understood and agreed that the necessary clearing shall be done by the contractor, in accordance with the provisions of this subsection, but that payment for The Work shall be presumed to be included and absorbed by the prices bid for other items.

This item, when included in the proposal, shall be paid for on the basis upon which it was bid, which price and payment will be full compensation for The Work.

SUBSECTION 10.10 GRUBBING.

10.11 DESCRIPTION. Grubbing shall consist of the excavation, removal and disposal of roots, stumps, stubs, together with duff, matted roots, and buried debris from the grubbing limits, as hereinafter defined, unless otherwise specified on the plans or directed by the engineer.

10.12 CONSTRUCTION METHODS. All areas of the right-of-way so designated on the plans or in the proposal, and all areas between lines five (5) feet outside of the grading limits for cuts, channels, ditches and pits, and all areas to be covered by embankments less than three (3) feet in height, shall constitute the grubbing limits. All stumps, roots, logs or other timber more than three (3) inches in diameter and all brush, matted roots and other debris within the grubbing limits, not suitable for road foundation, shall be pulled or otherwise removed to a depth of not less than twelve (12) inches below the original ground surface.

All material resulting from grubbing operations shall be piled and burned as stipulated under Subsection 10.00, provided, however, that any such material not disposed of by burning shall be disposed of out of sight from the Highway or neatly piled not less than three hundred (300) feet outside of the right-of-way, and written permits for such disposal shall be obtained by the contractor from the owner of the property upon which the material is placed and such permits or copies thereof shall be filed with the engineer.

Burning of grubbing debris shall normally be performed prior to grading operations; however, in the event burning permits cannot be secured from the proper authorities at the time contemplated for disposal of such debris, failure to secure such permits shall not be cause for delay in removal of grubbing debris from within areas affected by other operations. In such event the work under the item of "Grubbing" shall be construed to include placing of grubbing debris beyond the limits affected by other work until such time as burning permits can be secured, and rehandling and disposal of such debris done without delay to other work. Grubbing shall be kept at least one thousand (1,000) feet ahead of grading operations. All depressions below the final surface of the ground, resulting from the grubbing operations, shall be backfilled with suitable

material. Material secured from excavation operations for this backfilling will be paid for as provided under Subsection 11.00 and Section 12.

10.13 METHOD OF MEASUREMENT. The boundaries of the areas to be cleared will be established by the engineer by the use of stakes, lath, flags, or other satisfactory means.

When "Grubbing" has been bid at a unit price per acre the acreage to be measured and paid for will be the number of acres, computed to the nearest hundredth, actually grubbed and accepted as completed. Acreage will be determined from horizontal measurements.

When "Grubbing" has been bid at a lump sum price the item shall include all necessary grubbing, as defined in this subsection, involved in the satisfactory completion of the Project.

10.14 BASIS OF PAYMENT. If there is some "Grubbing" work that should be performed on the Project, and there is no "Grubbing Item" in the proposal, then it is understood and agreed that the necessary grubbing shall be done by the contractor, in accordance with the provisions of this subsection, but that payment for The Work shall be presumed to be included and absorbed by the prices bid for other items.

This item, when included in the proposal, shall be paid for on the basis upon which it was bid, which price and payment will be full compensation for The Work.

SUBSECTION 10.20 CLEARING AND GRUBBING.

10.21 DESCRIPTION. "Clearing and Grubbing" shall consist of clearing the ground of all trees, brush and rubbish within the limits designated for clearing and for doing the necessary grubbing, as hereinbefore provided in Subsections 10.00 and 10.10.

10.22 CONSTRUCTION METHODS. The work shall be done in accordance with the provisions contained in Subsections 10.00 and 10.10.

10.23 METHOD OF MEASUREMENT. The boundaries of the areas to be cleared and grubbed will be established by the engineer by the use of stakes, lath, flags or other satisfactory means.

When "Clearing and Grubbing" has been bid at a unit price per acre the acreage to be measured and paid for will be the number of acres, computed to the nearest hundredth, actually cleared and grubbed and accepted as complete. Acreage will be determined from horizontal measurements.

If an item is included in the proposal calling for a lump sum price for all "Clearing and Grubbing," then no measurements for purposes of payment will be made other than those

measurements necessary to determine whether the contractor has actually cleared and grubbed the specified areas.

10.24 BASIS OF PAYMENT. If there is some "Clearing and Grubbing" work that should be performed on the Project, and there is no "Clearing and Grubbing Item" in the proposal, then it is understood and agreed that the necessary clearing and grubbing shall be done by the contractor, in accordance with the provisions of this subsection, but that payment for The Work shall be presumed to be included and absorbed by the prices bid for other items.

This item, when included in the proposal, shall be paid for on the basis upon which it was bid, which price and payment will be full compensation for The Work.

SUBSECTION 10.30 ROADSIDE CLEAN-UP.

10.31 DESCRIPTION. "Roadside Clean-up" shall consist of cleaning up roadside areas in accordance with this specification. The areas to be cleaned up shall be those areas so denoted on the plans or designated by the engineer, located in any case beyond the road prism slope lines. Clean-up shall consist of clearing the designated ground of down timber, dead brush, logs and debris, the felling and destroying of such snags and dangerous trees, within the area designated to be cleaned and the burning or other disposal of the spoils, as ordered by the engineer. Clean-up shall also include the removal, from cultivated or cropped areas, of all dead plants and plant refuse and shall include living crop plants when so ordered by the engineer.

"Roadside Clean-up" also will include the removal and disposal of all obstructions, buildings, structures, fences, building foundations, debris, rubbish, rubble, junk, or any other material not intended to be a part of the completed highway; the filling and surface finishing of basements of former buildings, trenches, and other holes or excavations which are not to be a part of the finished highway.

10.32 CONSTRUCTION METHODS. The neatness of cleaning up shall be relative, so as to be in character with the surroundings. Hand raking or any similar exaggerated degree of treatment shall not be required.

Intensity of clean-up shall be gradually diminished from the road prism construction outward to the clean-up limits or boundary designated by the engineer, so as to effect a natural transition in treatment, and so as to avoid sharp demarcation between the artificial and the natural.

As a general guide, the first twenty (20) foot width nearest the roadway shall have practically all small sticks and other loose particles removed, except those of approximately one inch or less in thickness or diameter. The second twenty (20) foot width shall be cleaned of substantially all sticks and loose

particles, exceeding approximately two inches in thickness or diameter, and the third twenty (20) foot width shall be cleaned of substantially all sticks and loose particles exceeding approximately three inches in thickness or diameter. Trees and snags designated for removal shall be cut flush with the ground. Stumps within the area designated for cleanup also shall be cut flush with the ground. Refuse from clean-up operations shall be disposed of as provided under Subsection 10.00.

10.33 METHOD OF MEASUREMENT. The unit of measurement will be the acre or on a "lump sum" basis, as set forth in the proposal form. In no case will any area within the road prism slope lines be included in the measurement for payment. The area to be paid for will be the number of acres, computed to the nearest hundredth, of land cleaned up as staked and ordered by the engineer and in accordance with this specification. Acreage will be computed from dimensions measured horizontally.

10.34 BASIS OF PAYMENT. If there is some "Roadside Clean-Up" work that should be performed on the Project, and there is no "Roadside Clean-up Item" in the proposal, then it is understood and agreed that the necessary roadside clean-up shall be done by the contractor, in accordance with the provisions of this subsection, but that payment for The Work shall be presumed to be included and absorbed by the prices bid for other items.

This item, when included in the proposal, shall be paid for on the basis upon which it was bid, which price and payment will be full compensation for The Work, excepting any extra work or rehandling of spoils materials due to delayed burning, as ordered by the engineer, not made necessary by fault or negligence of the contractor.

SECTION 11

EXCAVATION AND EMBANKMENT

SUBSECTION 11.00 ROADWAY, DRAINAGE AND BORROW EXCAVATION.

11.01 DESCRIPTION. Roadway, drainage and borrow excavation shall consist of excavating and grading the roadway and borrow pits, including gutters, ditches, channel changes, furrows, parking areas, intersections and approaches, slope rounding, benches on backslopes and benches under side-hill fills; excavation and removal of unsuitable material from the roadbed and beneath embankment areas; removal and disposal of slides; excavating selected material found in the roadway which is ordered for specific use in the improvement; removal and

disposal of all unsuitable and surplus materials occurring within the limits of the work; and disposing of all excavated material, all in accordance with the specifications and in conformity with the lines, grades, and dimensions shown on the plans or as staked by the engineer.

11.02 TYPES OF EXCAVATION. (A) "UNCLASSIFIED EXCAVATION" shall be defined as excavation and specified disposal of any and all material described in Article 11.01, regardless of type or nature, in areas designated by the plans or staked and directed by the engineer. When the proposal contains no other type of excavation defined in this Article, this item shall cover and include all types. When the proposal contains one or more of the other types of excavation defined herein, then "unclassified excavation" will include all excavation and disposal described in Article 11.01 excepting those specifically set forth in the proposal.

(B) "UNCLASSIFIED BORROW EXCAVATION" shall be defined as excavation and specified disposal of any and all material, regardless of type or nature, obtained from borrow pits or areas designated as such by the plans, all in accordance with the plans and as staked by the engineer, for use in embankments, approach roads, dikes and other purposes. Such sources may be selected and agreed upon as borrow by the engineer and the contractor after the contract has been awarded in cases where specified borrow is insufficient in acceptable quantity. "Unclassified borrow excavation" shall include the widening of ditches and flattening of back-slopes when such a procedure becomes necessary after the contractor has commenced excavation in a staked "cut," but only when "unclassified borrow excavation" is a bid item in the contract. The price bid for this item shall include clearing and removal of unsatisfactory materials and each borrow pit or area, after excavation has been completed, shall be finished and trimmed to a neat appearance satisfactory to the engineer and property owner. The right to use of a borrow area shall be designated on the plans—either furnished by the Commission or the contractor.

(C) "UNCLASSIFIED CHANNEL EXCAVATION" shall be defined as excavation of any and all materials, regardless of type or nature, involved in constructing new water courses or channels or for widening, deepening or straightening existing channels, including designated disposal of the material, all in accordance with plans and as staked by the engineer. This type of excavation shall be paid for only when designated by the plans as such and when bid upon by the contractor.

(D) "STREET EXCAVATION" shall be defined as all necessary excavation and removal of any and all material, regardless of type, to attain the specified template for city streets or such sections of Highway designated on the plans. This type shall be used only when designated and bid upon by the contractor.

(E) "TRENCH EXCAVATION" shall be defined as excavation and removal of material from relatively narrow and generally deep trenches such as might be constructed for pipe and sewer lines. Such trenches will be shown on the plans. This type shall be used only when designated and bid upon by the contractor.

11.03 CONSTRUCTION METHODS. (A) **G r a d i n g.** Before ground is broken for excavation, all clearing and grubbing required shall have been performed on those areas in accordance with the specifications for that work. All suitable materials removed from the excavation shall be used insofar as practicable in the formation of the embankments, subgrade, shoulders, and at such other places as designated or directed. All excavated material shall be disposed of as directed and no payment will be made for any excavated material which is used for purposes other than those designated.

No material from borrow pits shall be used until it is determined that all roadway and drainage excavations can be utilized in the embankments. Borrow areas will be designated either on the plans or by the engineer. Material taken as borrow prior to being staked by the engineer will not be paid for.

When so directed, cuts shall be uniformly widened and slopes flattened, where necessary, to obtain additional excavation for embankments or to increase stability of slopes. When rock is encountered, where slopes will stand at a steeper slope than shown in the plans, the slopes shall be steepened as directed.

Where the ground foundation for embankments is composed of muck or other unstable materials such materials shall be removed to the depth shown on the plans or as directed by the engineer and satisfactorily disposed of. The excavated area shall be backfilled with suitable material as directed.

The engineer may permit the use of excavated rock for other purposes than embankments, in which cases the contractor shall furnish and place, at his own expense, an amount of borrow, if required, equal to the deficiency caused by the rock being used elsewhere. Rock, hard sandstone, shale, or other solid unyielding materials, when encountered in cuts, shall be excavated to the depth indicated in the plans or to a minimum of 12 inches below subgrade and backfilled with acceptable material. Soft and spongy spots shall be excavated to the depth below subgrade as directed. When there is a transition from excavation to embankment, and the natural ground slope is greater than 6:1, additional excavation shall be performed by benching so that no natural ground surface will remain closer than 12 inches to the top of subgrade.

When encountered, material suitable for backfill or road finishing purposes shall be excavated in such sequence that the material can be placed direct in final position on the top portion of the roadbed or as otherwise directed. When this cannot be

accomplished, and when so directed, such suitable material shall be stockpiled for subsequent placing in final position as required.

During the construction of the roadway the roadbed shall be maintained in such a condition that it will be well drained at all times. Side ditches or gutters emptying from cuts to embankments shall be so constructed as to avoid damage to embankments by erosion. The contractor shall maintain, and keep open and free from leaves, sticks and other debris, all ditches constructed by him until final acceptance of the project.

The top eight inches of the subgrade in cut sections shall be compacted in accordance with Article 11.88.

(B) Sloping. The slopes of all cuts, ditches, embankments and all earthwork structures shall be constructed and dressed in a neat and workmanlike manner according to the plans or as directed. Hand trimming will not be required where a neat uniform face is otherwise obtained. The slopes in all cuts and banks of borrow pits shall be trimmed from top to bottom in firm material and all loose material at the bottom of slopes shall be removed or blended in with the general work.

(C) Shaping. After all earthwork has been substantially completed, all structures are complete, and all drains are laid, the entire surface of the roadbed shall receive a finish shaping with a grading machine, supplemented by hand work where necessary, to secure a smooth surface and uniform cross section. Rock sections and all other sections, where the natural material is not considered suitable, shall be brought to grade by depositing, to the depth authorized, a satisfactory cushion of selected material.

(D) Finishing. The entire roadbed shall be brought to the final elevation and shape indicated on the plans and dressed as directed. No roots, sod, or other deleterious matter shall be left within the top 4 inches of the finished subgrade surface. Oversize material, either loose or partly buried, that will not pass a 4-inch square screen shall be removed from the entire surface of the roadbed and shall be disposed of as directed. The finished grade shall not deviate more than one-tenth foot at any point from the staked elevation and, provided further, that the sum of the deviations from true grade of any two points not more than 30 feet apart shall not exceed one-tenth foot.

In order to secure a smooth even surface to the finished subgrade the contractor shall use a self-propelled motor grader weighing not less than 20,000 pounds with a minimum blade length of not less than 12 feet.

11.04 METHOD OF MEASUREMENT. All accepted roadway, drainage and borrow excavation shall be measured by the cubic yard in its original position by the method of average end areas. Measurement will include all slides not due to the carelessness of the contractor and authorized excavation of rock and soft

spongy spots below grade or below original ground line of embankment areas. The measurement shall include unavoidable over-breakage in solid rock excavation to an amount not to exceed, in any half station of 50 feet, 10 per cent of the actual quantity required for the same half station within the lines shown on the plans.

Excavation used as selected material or stockpiled as such shall be measured by the cubic yard in its original position. When removed from the stockpile and placed as directed, it shall again be included for measurement according to the volume in its original excavated position.

Unless otherwise specified, "clearance of right-of-way" (Section 10) within the limits of The Work shall be considered as incidental to and necessary to performance of roadway, drainage and borrow excavation and shall be performed at the contractor's sole expense.

11.05 BASIS OF PAYMENT. All accepted roadway, drainage and borrow excavation shall be paid for at the unit price bid per cubic yard for the specified excavation unless otherwise stipulated, which price and payment shall be full compensation for clearance of right-of-way, preparation, formation, sloping, shaping and finishing embankments, subgrades, shoulders and roadway and all other excavation within the limits of The Work; disposal of surplus material, excavating below subgrade and embankment foundation areas, roadway and drainage excavation for selected material, rounding tops of slopes and shall include the furnishing of all labor, tools, equipment and incidentals necessary to complete The Work in accordance with this specification.

SUBSECTION 11.50 SPECIAL BORROW.

11.51 DESCRIPTION. "Special Borrow" shall consist of the excavation and placing of materials obtained from accepted sources designated in the plans, stipulated in the proposal or from authorized supplementary sources. Generally, "Special Borrow" shall be placed in layers or courses immediately below subgrade surface on embankments and through cuts to such thickness as is specified in the plans or proposal.

11.52 CONSTRUCTION METHODS. Special Borrow excavation shall be performed in accordance with pertinent provisions of Subsection 11.00. All material not suitable for Special Borrow shall be removed from the borrow area and disposed of as directed. Placing of Special Borrow on roadway embankments and cuts shall be in conformance with the provisions of Article 11.85, except as may be otherwise stipulated in the proposal or shown in the plans.

11.53 METHOD OF MEASUREMENT. Special Borrow, when specified, will be measured by the cubic yard in its original

position by the method of average end areas unless specified otherwise.

Other items required of the work, when specified, will be measured by the unit stipulated in the proposal.

11.54 BASIS OF PAYMENT. Special Borrow will be paid for at the unit price bid for all special borrow used in the accepted and completed work, which price and payment will be full compensation for The Work. No payment whatever will be allowed the contractor for removal and disposal of unsuitable materials from borrow areas, nor will payment be allowed for special borrow removed from areas prior to the staking and cross-sectioning thereof.

Other items specified will be paid for at the respective contract unit bid price, which price and payment shall constitute complete payment for The Work.

SUBSECTION 11.60 EXCAVATION FOR CULVERTS AND RETAINING WALLS.

11.61 DESCRIPTION. "Excavation for Culverts and Retaining Walls" shall consist of all excavation for foundations for culverts, retaining walls, riprap, masonry and other minor structures and for excavation necessary for the removal of culverts from existing roadbeds and from other locations, and shall include the disposal of all material obtained from such excavation and backfilling to the level of the original ground. The proposal shall prescribe the particular type or types of excavation involved in the Project.

11.62 CLASSIFICATION. All material excavated shall be unclassified and paid for as culvert excavation unless otherwise provided in the special provisions.

The excavation lines and bases of culverts shown on the plans shall be considered as approximate only, and they may be ordered in writing by the engineer to be placed at any elevation, or of any dimensions necessary to give a satisfactory foundation, and no additional compensation will be allowed for any such change except as provided under basis of payment.

Boulders, logs, or any unforeseen obstacles encountered in excavating shall be removed and no additional compensation will be allowed because of difficulties found in removing such obstructions.

Culvert excavation shall include only that excavation which is removed from below the lines of the planned or staked template section, whether it be roadway, channel change or otherwise. When the culvert excavation takes place in embankment sections, then the culvert excavation shall be that between the original ground line and the template lines established for the culvert bedding.

11.63 CONSTRUCTION METHODS. All material excavated shall be unclassified and will be paid for as specified. Rough excavation for retaining walls shall be made to finished ground line at the face of the wall. Below this line trenches of necessary width shall be excavated, to specified lines. All bearing points and areas shall be at specified grade, firm and solid, and approved by the engineer. The excavation lines and grades of culverts shown on the plans shall be considered as approximate only, and they may be directed to be placed at any elevation or location, or of any dimensions necessary to give a satisfactory foundation or to provide more suitable drainage and no additional compensation will be allowed for removing such obstructions.

11.64 METHOD OF MEASUREMENT. Excavation, unless otherwise specified, will be measured to the nearest one-tenth (0.1) cubic yard in its original position removed in the completed and accepted work. Measurement will only include excavation bounded by the bottom planes as established and twelve (12) inches outside the neat lines of vertical planes, including ends, of all culverts, walls and other minor structures. Where forms are required, the measurement may include eighteen (18) inches outside the neat lines. For structural plate types, measurement may be extended to twenty-four (24) inches outside neat lines.

Excavation for riprap, rubble masonry, retaining walls and such structures shall be considered to be absorbed by the price bid for such items, unless specified otherwise. When the proposal specifies excavation for such structures or items measurement shall be by the cubic yard to the nearest one-tenth (0.1).

11.65 BASIS OF PAYMENT. Excavation will be paid for at the contract unit bid price as set forth by the proposal, which price and payment shall be full compensation for The Work.

SUBSECTION 11.70 DISPOSAL OF SURPLUS MATERIAL.

11.71 DESCRIPTION. "Disposal of Surplus Material" shall consist of the disposal of all surplus excavated material including rocks brought to the surface by scarifying. The material shall be disposed of by widening embankments or by flattening slopes, or by depositing the material in such other places and for such other purposes as may be directed. Large rocks brought to the surface by scarifying or otherwise, shall be disposed of in such manner that they will not be noticeable from the completed roadway.

The Work described herein will not be measured or paid for directly. It shall be considered a necessary part of and incidental to The Work involved of the other items of the contract.

SUBSECTION 11.80 EMBANKMENT.

11.81 DESCRIPTION. "Embankment" shall consist of the construction of all roadway fills and dikes, placing of miscellaneous backfills, within or without the right-of-way, to the lines, grades, dimensions and typical section shown in the plans or as designated and at those locations and to such revised widths, heights and dimensions as the engineer may consider necessary to allow for settlement, consolidation and compaction of the embankment, the compacting of embankment foundation areas and the embankment material as it is being placed, all in accordance with the plans and the specifications.

11.82 MATERIAL. Suitable material shall be secured from designated roadway and drainage, structure, culvert or borrow excavation in conformity with the lines and grades and locations shown in the plans and as directed. Stumps, trees, logs, rubbish, vegetation or other unsuitable materials shall not be placed in embankments. Sod mixed with surface soil and soil containing large amounts of humus or other organic materials shall, as far as practicable, be spread over the embankment slopes or incorporated in the embankments outside of the shoulder lines. Pockets of rocks or muck will not be permitted. Frozen material shall never be placed in embankments.

When an embankment is adjacent to or parallel to a stream or channel, rock encountered in excavation shall be used, as far as possible, to protect the slope by dumping and working the rock to the stream side of the fill.

11.83 CONSTRUCTION METHODS. General. When embankments are to be placed on a hillside, or where new fill is to be placed against existing embankment, or where the fill is to be constructed one-half width at a time, the slope of the original hillside, or old or new fill respectively, shall be benched or stepped by cutting into it horizontally, for a minimum distance of eighteen (18) inches to provide for secure bonding of the embankment while it is being brought up in layers. Each bench shall be cut as close to the one below as the slope of the ground will permit. Material thus cut out of the benches shall be incorporated into the new fill at the contractor's expense.

Where embankments are to be made and compacted on original hillside, old or new fill, the slopes of the original ground, or fill, except in the case of rock slopes, shall be plowed or benched before filling is commenced.

Where embankment is to be constructed on a previously bituminous-surfaced roadway, the old surface courses shall be scarified to the full depth of the surfacing in place in order to break the surface seal, to aerate the old surfacing material and provide for a bonding of the new embankment material to be placed. The old surface material shall be recompacted prior to placing embankment material.

When embankment is to be constructed across low swampy ground that will not support the weight of hauling equipment,

the lower part of the fill may, if approved by the engineer, be constructed by dumping successive loads of material in uniformly distributed layers of a thickness not greater than necessary to support the hauling equipment while placing subsequent layers in the previously specified standard manner.

Whenever the surface of a cut or the site of an embankment is covered with snow or ice, sufficient to impair the stability of The Work, the snow and ice must be removed and deposited beyond the slope stakes at the contractor's own expense. Work of this nature shall be completed at least 300 feet in advance of the excavation and placing of the embankment material. Frozen excavation or that lying under a blanket of snow of such extent as to preclude its placement in the embankment, will be considered cause for shutting down grading operations.

If it should become necessary, because of weather or other conditions, to suspend grading operations the entire area worked upon shall be bladed smooth, free of depressions and ruts and crowned so that no water can collect or be impounded on the roadway.

Embankment constructed to grade and cross section during the winter shall be refinished to grade and cross section after the frost is out of the ground and the embankment is in suitable condition for this work.

Embankment material, other than as specified in Article 11.84, shall be placed and compacted in accordance with Articles 11.85 and/or 11.86. Methods I and II will govern the construction of embankment dependent upon the type of excavation material being placed therein, and compaction shall meet the density requirements set forth in Article 11.88, unless specified otherwise.

11.84 EMBANKMENTS AT STRUCTURES. Embankment and backfill placed adjacent to structures and for a distance of ten (10) feet therefrom, shall be brought up in equal layers, not more than 6 inches in thickness, on all sides of the timbers or trestles, or bulkheads, columns, or around small structures or culverts to prevent distortion of any of the structure members of structures or culverts. Areas inaccessible to rollers shall be compacted by mechanical tampers or other means until the density conforms to that specified under Article 11.88, provided however, that for embankment other than at structures, the compaction required shall not exceed that of the adjacent embankment, compacted in accordance with these specifications.

11.85 METHOD I. The material shall be placed in uniform, approximately horizontal layers not to exceed eight (8) inches in loose thickness, for the entire width of the embankment and not less than three hundred (300) feet in length or for the entire length of the embankment. Each layer of embankment shall be completed, leveled and compacted before the succeeding layer is placed.

Material shall be spread, manipulated and kept leveled by means of a power grader weighing not less than twenty-thousand (20,000) pounds, with a minimum blade length of twelve (12) feet and/or a tractor angle or bull dozer combination weighing not less than twenty-thousand (20,000) pounds with a minimum blade length of ten (10) feet.

Levelling equipment of the kind specified shall be kept in continuous operation at all times the embankment is being constructed for the purpose of spreading and manipulating the material in blending it to uniform character, levelling and compacting it as it is placed in the embankment. Hauling equipment shall be routed to distribute travel over the entire area of each layer of material and over the entire width of the embankment being constructed and separate pieces of equipment shall not follow in the immediate tracks of preceding equipment. The embankment surface is to be kept level and uniform at all times. The sides of the embankment shall be constructed first and the center shall be brought up level with the shoulders.

Embankment material shall not be placed when the moisture incorporated in, or existing in, any layer causes excessive rutting by hauling equipment or when such moisture precludes proper compaction. Embankments rendered unstable by excessive amounts of moisture from any cause shall be dried by scarifying and blading the affected areas before placing succeeding layers.

Compaction shall meet the density requirements set forth in Article 11.88, unless specified otherwise.

When "watering" is specified, water shall be applied in the amounts, and over the areas and at the times, while embankment material is being placed, as directed. When specified, rolling shall be accomplished in accordance with Section 14 on the designated areas, while the embankment material is being placed.

11.86 METHOD II. Embankments formed of material containing by volume twenty-five (25) percent or more of rock larger than six inches in diameter shall be placed in layers of sufficient depth to contain the maximum size of rock present in the material; provided, however, that in no case shall the thickness of layers before compaction exceed twenty-four inches. Material containing rock shall be deposited on the material being compacted and spread over the preceding layers by dozers or other specified levelling equipment and the interstices shall be filled with finer material to form a dense compact mass. Even though the general thickness of layers is limited the placing of individual rocks and boulders of a size not exceeding forty-eight inches in least dimension will be permitted, provided they are carefully distributed and the interstices filled to form a dense compacted mass. Except for the provisions herein referred to describing the thickness of layers

permitted to be placed, placing of embankment material under Method II shall conform to Article 11.85.

11.87 METHOD III. When shown in the plans or stipulated in the proposal, embankments and subgrades shall be constructed in accordance with the following requirements. Material shall be placed as required under Method I, except that the maximum thickness of each layer shall contain only the amount of material which can be compacted to the specified density with the equipment used, in case the material contains less than twenty-five (25) percent of rock larger than six inches in greatest dimension then no layer shall exceed eight inches in loose depth. Each layer of embankment material shall be disced or harrowed sufficiently to break down clods over six inches in their greatest dimension, to thoroughly mix the various materials and to secure a uniform moisture content. Each such layer shall be carefully leveled to a designated thickness before compacting so as to insure uniform and proper compaction.

Compaction of embankments, including backfilling and preparation of embankment foundation areas, shall be accomplished by whatever equipment is necessary and at such moisture content as is required to provide the density hereinafter specified, as determined by tests, while the embankment material is being placed. The compactive effort required to obtain the specified density is dependent, within certain limits, upon the moisture content of the material and the control thereof.

Where embankments are to be placed on soils having a relative compaction of less than ninety per cent determined by AASHO Method T 99, and/or equivalent methods, the ground surface shall be scarified, watered and compacted before placing embankment material until a relative compaction of at least ninety per cent is reached in the upper eight inches of the compacted soil. Should lightly compacted soils be encountered that extend to depths greater than eight inches, the upper portion thereof, to a width equal to the width of the roadbed plus 1:1 supporting slopes, shall be removed to the depth ordered by the engineer, after which the ground surface shall be compacted until a relative compaction of ninety per cent is reached in the upper eight inches. Material removed as herein provided shall be placed in embankment directly from excavation as directed by the engineer, or it may be placed alongside the trench and replaced therein after compaction operations have been completed within the excavated area. The material in the top eight inches of the subgrade in cuts shall be compacted to the same density as that in adjoining embankments.

The removal of lightly compacted soil, and the placing of it in embankment at other locations or the replacing of the material in the trench after compaction operations have been completed will be paid for as roadway excavation. Should the contractor elect to place the excavated material alongside the trench and replace the material after compaction operations have been completed, no allowance in pay quantities will be

made for replacing the material, full compensation for such work being considered as included in the price paid per cubic yard for removal of the material as roadway excavation.

Embankment material which does not contain sufficient moisture to compact in accordance with the above requirement shall be watered prior to compaction. Material containing an excess of moisture shall be dried before being compacted.

11.88 DENSITY REQUIREMENTS. Unless otherwise specified, each layer of embankment shall be compacted until the density of compacted material in the embankment shall be not less than the percentage of the minimum density set forth herein. Tests for laboratory densities shall be performed in accordance with AASHO T 99, Method 'A' or 'C,' dependent upon the gradation of the material involved, or an equivalent method.

MINIMUM FIELD COMPACTION REQUIREMENTS — AASHO M 57

Standard of Compaction Pounds per Cubic Foot	Minimum Compaction Required, Per Cent of Maximum Density
90 - 99.9	100
100 - 109.9	95
110 - 119.9	95
120 - 129.9	90
130 and above	90

The field density shall be determined in accordance with AASHO T 147. The percentage compaction of the aggregate admixture shall be calculated after having made proper adjustment for the weight and volume of material larger than $\frac{3}{4}$ inch sieve size.

11.89 METHOD OF MEASUREMENT. Embankment construction will not be measured directly for payment but shall be considered subsidiary to and necessary of all excavated material required to construct roadway fills, embankments, dikes and backfill.

When stipulated in the proposal "watering" and "rolling" required under Methods I or II shall be measured according to the unit bid.

When "Subgrade Compaction" is specified in the proposal form as a bid item, the quantity or volume to be paid for shall

be the actual yardage of unclassified excavation incorporated in the roadway, measured as provided by Article 11.04. Road approaches, turnouts, wyes, and other such facilities shall be included as part of the roadway. Surplus and waste material, and excavation used as structure backfill or surfacing material, will not be included.

11.90 BASIS OF PAYMENT. Embankment construction will not be paid for directly, unless specified otherwise, but shall be considered a necessary part of The Work, and included in the unit price bid for all excavation required to construct the embankment which prices and payments shall include all labor, tools, equipment and incidentals necessary to placing, levelling, manipulating, drying embankment material, plowing hillsides, cutting into old fills and scarifying old roadway surfaces and all costs incidental to completing The Work in accordance with these specifications.

When stipulated in the proposal "rolling" and "watering" required under Method I or II will be paid for at the contract unit bid price in accordance with Sections 14 and 15.

When the proposal specifies that embankments and subgrades shall be constructed in accordance with Articles 11.87, and provides a bid item for "subgrade compaction," payment shall be made in accordance with the following provision. "Subgrade Compaction" shall be paid for at the contract unit price bid per cubic yard, which price and payment shall be full compensation for all compactive effort necessary to obtain specified densities, for furnishing all equipment, scarifying, wetting, aeration, manipulations and other work required to produce the specified finished subgrade and embankments."

SECTION 12

OVERHAUL

12.01 DESCRIPTION. Overhaul will be considered as the distance in excess of 1,000 feet that a quantity of material, excavated under the provisions of Subsection 11.00, is hauled and placed or disposed of as shown on the plans, as specified in the specifications or as directed by the engineer. It is to be understood that a free haul distance of 1,000 feet is included in the contract price bid for excavating the material.

12.02 METHOD OF MEASUREMENT. Overhaul will be measured by the station yard or by the mile yard and will be computed by taking the product of the number of cubic yards of material removed from any excavation by the distance such material is hauled, in excess of the free haul distance of one thousand (1,000) feet, and placed in embankment or disposed of as directed.

The amount of overhaul will be determined by the mass diagram method, or its mathematical equivalent, as illustrated on the standard drawing, or drawings, concerning overhaul (Series 12).

The number of units of overhaul shall be, essentially, the product of the volume of the excavated material that is hauled and the net haul distance in feet, less 1,000 feet, (a) divided by one hundred (100), if payment is made on a station yard basis and (b) divided by five thousand two hundred eighty (5,280) if payment is made on a mile yard basis.

The distance such material is hauled will be taken as the distance between the approximate center of volume of such removed excavation and the approximate center of volume of the resultant embankment. The distance between centers of volume shall be measured along the centerline, or a line parallel with the main roadway under construction, and any additional distance of haul due to circuitry of travel or un-ordered crosshaul will not be considered. The haul distance on materials developed on the highway right-of-way, or right-of-way widened for borrow purposes, shall be measured entirely along the centerline of the roadway, unless otherwise noted on the plans. The distance right or left of centerline that the material originated or is deposited will not be considered or measured.

Haul distance on materials from sources off the highway right-of-way, such as borrow pits, shall be measured along the shortest practicable route, as established by the engineer, from the approximate center of volume of each pit to the point of entrance on the project; thence, along the centerline of the roadway to the approximate center of volume of the resultant embankment or other designated disposal.

OVERHAUL

Overhaul on materials from sources off the highway right-of-way will be determined by multiplying the volume excavated by the distance from the approximate center of volume of the excavated area to the project centerline, less the free haul distance, plus any haul that might be required along or parallel to the roadway centerline.

Excavation and embankment volumes for ramps, frontage roads, road approaches, driveways and connections on either side of the roadway will be considered as concentrated at the centerline, or a line parallel with the main roadway under construction, for computing overhaul quantities for payment.

The number of cubic yards of materials hauled will be determined by measurement of the materials "in excavation" with no allowance being made for any swell that may occur when the materials are excavated and loaded into the trucks or other conveyances.

12.03 BASIS OF PAYMENT. Overhaul, when so provided by the proposal, will be paid for at the contract unit bid price, which price and payment will be full compensation for The Work.

When not stipulated, by the proposal, overhaul of material will not be paid for directly but shall be considered incidental and necessary to the performance of and payment for the other contract items and shall include everything necessary to complete The Work.

SECTION 13 HAUL

13.01 DESCRIPTION. When so provided by the proposal, "Haul" will be paid for the transporting of various surfacing materials.

13.02 METHOD OF MEASUREMENT. Haul will be the number of ton miles or yard miles determined by multiplying the number of tons or cubic yards, as the case may be, of accepted material by the distance hauled in miles and fraction thereof. The haul distance will be measured to the nearest one-tenth (0.10) mile along the shortest practicable route, as determined by the engineer, from loading point to the point of deposition. If the contractor chooses to haul the material over some other route, and such route is longer, the computation for payment shall be based on the haul distance measured along the route designated by the engineer.

13.03 BASIS OF PAYMENT. "Haul", when so provided by the proposal, will be paid for at the contract unit bid price, which price and payment will be full compensation for The Work.

When not stipulated by the proposal, "Haul" of material will not be paid for directly, but shall be considered incidental and necessary to the performance of and payment for the other contract items and shall include everything necessary to complete The Work.

SECTION 14

ROLLING

14.01 DESCRIPTION. Rolling shall consist of the operation of various specified types of rollers as required for compaction of embankments, subgrade, aggregate surfacing, bituminous courses and cover aggregate, in conformity with these requirements and the specifications for the particular type of work involved.

14.02 EQUIPMENT. The types of rollers specified for the particular work shall conform to the following general requirements:

(A) Weights of the rollers shall be based on the manufacturer's rating or recommendation. Self-propelled rollers shall be powered adequately for the efficient accomplishment of the specified work and capable of reversible operation, devoid of back lash. They shall be in good mechanical condition and provided with positive accurate steering control. Pull type rollers shall be towed with truck or tractor power capable of efficient operation. Roller operation shall be separate and distinct and, other than with required traction units, rollers shall not be operated in combination with any other equipment. All types of rollers shall be equipped with such self-cleaning devices as are necessary to prevent adhesion of materials to the wheels or tamping surfaces.

(B) **Metal Wheeled Power Rollers,** shall be smooth wheeled and self-propelled.

(1) Tandem type weighing not less than five tons nor more than ten tons.

(2) Tandem type weighing not less than eight tons.

(3) Three wheeled type weighing not less than ten tons.

(C) **Tamping Rollers.** Tamping rollers shall consist of metal rollers, drums or shells, surmounted by metal studs with tamping feet projecting not less than seven (7) inches from the surface of the roller, drum or shell. The wearing surface of each tamping foot shall have an area of not less than four nor more than eight square inches.

The weight of the tamping roller shall be such that the load on the tamping foot wearing surfaces shall be not less than

three hundred (300) pounds per square inch of cross sectional area. Each and every tamping roller shall be subject to approval of the engineer.

(D) Pneumatic - Tired Rollers. Pneumatic - tired Rollers shall be of the two-axle type, straight or oscillating, mounted in a rigid frame and provided with a platform or body suitable for ballast loading and having an effective rolling width of not less than four feet. Under working conditions, unless otherwise specified, a pneumatic-tired roller shall have a minimum working weight capacity of two-hundred-fifty (250) pounds per inch width of tire tread.

The tires shall be smooth (no tread) and of equal size and diameter. The tires on the rear axle shall be so spaced that the entire tread gap of the preceding two tires will be covered by the tread of the following tire. They shall be uniformly inflated and the air pressure in the several tires shall not vary from each other more than five pounds per square inch.

The roller shall be capable of turning in such manner that the material being rolled or the adjacent roadbed shall not become dislodged or loosened. Depending upon specifications for the particular type work, the roller may be self-propelled or drawn by either suitable tractor or truck of adequate tractive power.

Use of wobble wheel pneumatic-tired rollers will not be permitted on bituminous surfacing work.

(E) Vacant.

(F) Other Types of Rollers. Use of other types of rollers and compacting equipment of recent design or invention and heretofore not described shall require the approval of the engineer prior to use.

14.03 CONSTRUCTION METHODS. **(A) General.** Each layer of a surface course or each layer of embankment where compaction is required shall be completely compacted by rolling and/or watering before the succeeding course or layer is placed. Rolling shall be extended completely across the roadway, commencing at the sides and progressing toward the center, overlapping each preceding passage by approximately one-half the width of the roller. On superelevated curves, rolling shall begin at the low side and progress toward the high side. Rollers shall operate at a nominal speed of between two and three miles per hour. Rolling shall be continued until the required compaction has been secured. The amount of rolling and watering on any type of work shall be determined exclusively by the engineer.

Along curbs, headers and walls and at all places not accessible to the rollers the area on any type of surface shall be compacted thoroughly with acceptable mechanical or hand tampers. Each hand tamper shall weigh not less than fifty (50) pounds and have a surface area of not more than one-hundred (100) square inches.

(B) Compaction of Embankment. Where compaction of embankment by rolling is specified, the rollers used shall be of the type described in Article 14.02 in accordance with requirements of Subsection 11.80 dependent upon the type of material. Pneumatic-tired rollers, as specified in Article 14.02(D) shall be used in addition to or instead of tamping rollers when directed.

(C) Compaction of Aggregate Surfacing. Compaction on any of these respective types of work shall be accomplished through an operation which coordinates use of the type of rollers specified in Part (B) and Part (D) of Article 14.02, as required in obtaining specified results.

Rolling shall commence with the initial blade layout of spreading each layer of surfacing material following its being completely mixed and blended and shall be carried on concurrently with the spreading process of the layer. No less than three complete passages of a roller of any type shall be required and rolling shall be continued until the surface is smooth and unyielding.

The amount of rolling and watering required shall be determined by the engineer. Each layer placed shall be bladed smooth and thoroughly compacted by rolling and watering before the succeeding layer is placed. The methods herein described shall be applied to placing each successive layer.

Blading, rolling and watering shall be performed alternately, as required or directed, until the resulting product is a smooth, even, uniformly compacted surface acceptable and ready for placement of a succeeding surfacing course.

(D) Compaction of Subgrade. Equipment and methods used for compaction of subgrades shall be the same as employed on aggregate surfacing, with the methods being modified in accordance with the conditions encountered by resulting in the degree of compaction specified by Subsection 11.80.

(E) Compaction of Bituminous Surfacing.

(1) Road Mix — See Section 34.

(2) Plant Mix — See Section 35.

(3) Bituminous Surface Treatment and Seal Coat — See Sections 33 and 36, respectively.

14.04 METHOD OF MEASUREMENT. Rolling will be measured in units determined on the basis of the compacting width of roller of six (6) feet and the hours of time actually consumed in rolling. The rolling units will be computed, therefore, by multiplying the time in hours actually consumed in rolling by the effective rolling width of the roller, in feet, and dividing the product by six (6). Time consumed in servicing or repairing the roller or in moving to and from the point where the work is to be done, will not be measured. When specified as being necessary, but not included in the proposal as a bid item, rolling will not be measured directly but shall be considered

incidental to the performance of the other items of the contract. No time shall be allowed for movement to and from the roadway or for delays and breakdowns.

14.05 BASIS OF PAYMENT. Rolling used in the completed and accepted work will be paid for at the contract unit bid price, which price and payment, except as otherwise expressly provided, will be full compensation for all operations necessary to complete The Work.

When specified as being necessary, but not included in the proposal as a bid item, rolling will not be paid for directly but shall be included in the payment for the other items of the contract.

SECTION 15 WATERING

15.01 DESCRIPTION. "Watering" shall consist of furnishing and applying water as required in the compaction of embankments, subgrades, and surfacing materials, in accordance with the requirements of the specifications.

15.02 CONSTRUCTION METHODS. **(A) Watering Embankments and Surfacing Aggregates.** Water, when required, shall be applied on the areas and in the amounts and at the times directed by the engineer. The contractor shall furnish and operate water applying tanks, equipped with spray bars, for use on embankments, subgrades and surfacing. They shall be mounted on pneumatic-tired trucks or pneumatic-tired trailers pulled by pneumatic-tired equipment. The minimum capacity of any water distributing tank shall be one-thousand (1,000) gallons. The water distributing equipment shall be constructed to provide and assure accurate and uniform distribution of the required rates of water per unit of surface area. The control valves shall be constructed to permit positive closing and to prevent leakage.

Sufficient equipment shall be available at all times to apply the amount of water required within the time interval necessary to secure proper results before evaporation, absorption, or drainage prevents or interferes with the required results. When directed by the engineer, watering may be done at night or at other times to minimize losses by evaporation, absorption or drainage.

(B) Pre-wetting Excavation Areas. The contractor may in lieu of or in addition to the methods provided by Part "A", pre-wet the material in excavation areas prior to removal of the material therefrom and its placement in embankment.

Excavation areas, such as cuts and borrow pits, shall be watered by means of a sprinkler irrigation method so controlled and regulated that the material to be taken from the excavation area and placed in embankment shall have a sufficient moisture content that it can be compacted to the required density by means of the compaction equipment specified and/or used by the contractor.

In carrying out this type of wetting procedure, it is essential that a sufficient curing period be allowed to permit the movement of the water downward after all necessary water has been applied so that the soil shall have a uniform moisture content approaching optimum for the full depth to be excavated. Excavation of the material from the area will not be permitted until the percolation of the water is such that the excavation area, for its full depth, has reached its field carrying capacity. This is necessary in order to give sufficient time for proper percolation of the water and prevent removal of unduly wet upper layers.

In order to insure effective downward movement of the water and to minimize run-off, the natural growth on the excavation area shall not be removed until all watering of the area has been completed; otherwise the contractor shall be required to rip the area on the contour of the ground to a depth of two feet on approximately four foot centers.

Stripping of the vegetation from any given excavation area shall be done within a reasonable time after all watering of the area has been completed in order to minimize evaporation. The time limit for such stripping shall be subject to the control of the engineer.

The placing of the sprinkler system, the regulation of the pressure on water lines, and the use of proper orifices on the sprinklers shall be such as to adequately water the excavation area only and to minimize any wastage of water. The engineer shall estimate and deduct any undue waste of water.

The amount of water applied to the excavation areas shall be that necessary to bring the material to optimum for the full depth of the excavation and any water used in excess of this amount shall be determined by the engineer and deducted from the metered quantity. In the event the material placed in the embankment is too wet and requires drying before compaction such drying operation shall be done at the contractor's expense. The contractor shall provide adequate drilling equipment for the purpose of checking the penetration of moisture for the full depth of the excavation area.

15.03 METHOD OF MEASUREMENT. (A) Watering will be measured by the number of one-thousand (1,000) gallon units as ordered, measured in the vehicle at the point of delivery on the road. Measuring may be done by a meter of an approved type, or manual count of the number of loads delivered or as counted by an approved type of a load counter affixed to the

vehicle. All equipment for measuring, such as a meter or load counter, shall be furnished and installed by, and at the expense of, the contractor.

(B) Water used in accordance with Article 15.02(B) shall be measured by an approved meter. The unit shall be the gallon, in thousands, to the nearest 1,000 gallons. The contractor shall submit proof, as to the accuracy of said meter, which shall be reasonably up-to-date.

15.04 BASIS OF PAYMENT. The accepted quantities of this item shall be paid for at the unit price bid per one-thousand (1,000) gallon unit, which price and payment shall be full compensation for The Work.

When the proposal does not stipulate an item of "Furnish and Maintain Water Plant", the performance of this item shall be considered incidental to and included in the other items of the contract. When stipulated in the proposal, the item, "Furnish and Maintain Water Plant", shall be paid for at the lump sum bid. No payment shall be made for the latter unless installation is authorized in writing.

Water used in surface cleaning preparatory to placing a subsequent course of bituminous surfacing or cover material will not be paid for separately but will be considered incidental to and included in payment for the other items of the contract.

Water used in accordance with Article 15.02(B) shall be paid for at the price bid per thousand gallons for water, which price and payment shall be full and complete compensation for The Work, including the source of supply.

SECTION 16 CONTINGENT CONSTRUCTION AND OPERATIONS

SUBSECTION 16.00 EQUIPMENT USE.

16.01 DESCRIPTION. "Equipment Use" shall consist of the furnishing, by the contractor, for use on the Project and for performance of work specified or directed by the engineer, any of the units of equipment herein described, when indicated by the plans or stipulated in the proposal.

16.02 EQUIPMENT. (A) General Requirements. Any equipment furnished shall be in good mechanical condition and shall have sufficient motive power for successful continuous performance of the assigned work. Any equipment not capable of meeting these requirements will not be permitted on The Work.

(B) Motor Grader. The motor grader shall be self-propelled and shall weigh not less than twenty-thousand (20,000)

pounds. It shall be equipped with a standard moldboard, not less than twelve feet in length, with suitable cutting edge, a scarifier standard to the unit, complete with suitable teeth, all positive power controlled.

(C) Dozer. The dozer may be either the angle or straight dozer type, not less than eleven feet in length, with suitable cutting edge, power unit controlled, attached to a tractor weighing not less than thirty-thousand (30,000) pounds with sufficient power to provide efficient operation. The dozer and tractor shall be considered as a single unit.

(D) Shovel or Dragline. This unit shall be the full revolving type equipped with either a dragline or shovel bucket, as The Work may require, of not less than one-half cubic yard manufacturer's rated capacity. In no case shall the bucket be larger than that for which the machine was designed. If work conditions require, the unit shall include a set of suitable track bearing mats.

(E) Scraper. The scraper shall be of the pneumatic-tired carryall type, standard to a twelve cubic yard truck load capacity, supplied with tractive power adequate to its efficient loading capacity performance.

(F) Tractor-Loader. The tractor-loader shall be the front end, one cubic yard, bucket type, with full power control mounted on either a wheel or crawler tractor.

(G) Aggregate Spreader. This unit shall be self-propelled and rubber mounted.

16.03 METHOD OF MEASUREMENT. Equipment use will be measured by the hour, for the use of any unit specified, for its actual use in the performance of the assigned work. Time consumed in moving equipment from point to point on the Project and for repairing and servicing will not be measured.

Measurement of the respective excavating loading unit hours will be adjusted up or down from the specified standard load capacity to reflect the actual efficient load performance capacity with the motive power necessary. Adjustment will be based on a direct capacity bid price ratio.

16.04 BASIS OF PAYMENT. Equipment use will be paid for at the unit price bid per hour for the unit, when stipulated in the proposal, which price and payment shall include furnishing the equipment on the Project in completely operable condition, including operator, servicing, repairs and all incidentals necessary to complete The Work.

SUBSECTION 16.10 EXISTING SURFACE PREPARATION.

SUBSECTION 16.20 EXISTING SURFACE REMOVAL.

16.11 DESCRIPTION. "Existing Surface Preparation" shall consist of reshaping, to the typical section, and truing the grade

line of a previously completed earth subgrade section or gravel or bituminous surfaced roadbed, as the case may be, in preparation for the immediate construction of new surfacing as required by the specifications and plans.

16.21 "EXISTING SURFACE REMOVAL" shall consist of the removing and disposal of the existing surface from the areas and to the depth required by the specifications and plans.

16.12 and 16.22 CONSTRUCTION METHODS. This work shall be accomplished in accordance with one of the methods herein described and as required by the plans for the particular type of new surfacing or by the method stipulated in the proposal.

16.12 EXISTING SURFACE PREPARATION. (A) Subgrade. All soft and unstable areas in the subgrade shall be excavated, the undesirable material removed from the roadway and the excavations backfilled with material satisfactory to the engineer. Holes and depressions which cannot be brought to true line and grade by blading shall be filled with suitable material, as directed. The entire subgrade surface shall be bladed to true line and grade, and in conformance with the typical section. Roadway ditches shall be bladed clean and maintained for effective drainage. Shoulder lines shall be trued and roadway slopes shall be shaped and sloped to a point below the shoulder, consistent with the toe of the inslope elevation, to present a general uniform appearance of the work as required by the plans. After final blading, the surface shall be watered and compacted in accordance with the requirements of the respective specifications. It shall be maintained by the contractor, in the reconstructed condition, until the surfacing is placed.

All materials required to place the subgrade in acceptable cross-section and all rolling and watering required to secure adequate compaction will be measured for payment.

(B) Aggregate Surfaces. Equipment, methods of work performance and general requirements for aggregate surfacing preparation are essentially identical with those specified in Article 16.12(A). When the aggregate surface is to be applied with any type of bituminous surface, the surface shall be prepared in accordance with the requirements thereof. Any rocks or other similar objects protruding through the surface shall be removed and satisfactory repairs effected.

(C) Bituminous Surface. If the surface on which any surfacing material is to be placed is an existing bituminous surface such surface shall be removed or left in place as stipulated in the proposal or shown on the plans. If removal is indicated, the existing surface shall be scarified, broken up and disposed of as directed.

If the bituminous surface is to be left in place, the surface shall be prepared as follows: Where the existing bituminous surface or bituminous patches show an excess of bituminous material, and where bituminous surfacing material has been

placed over major settlements in the subgrade, the bituminous surfacing material shall be removed or reworked and satisfactorily stabilized as directed. Where the existing bituminous surface is corrugated, due to excessive amounts of moisture in the underlying surface courses or the subgrade, the unsuitable material shall be removed and the subgrade stabilized by drying and the surface material reworked and relaid or replaced as directed. When unsuitable materials are removed entirely, the affected areas shall be brought up to grade and typical section by backfilling with surfacing material as specified. These areas shall be satisfactorily compacted by watering and rolling and a prime coat of bituminous material applied to the final surface.

Immediately prior to placing any bituminous levelling material, course or courses the existing surface shall be thoroughly cleaned of dirt and loose or extraneous material by means of power brooms, hand brooming, water washing or other methods necessary to accomplish satisfactory results. If stipulated in the proposal, or directed by the engineer, a prime or tack coat of bituminous material shall be applied to the cleaned surface in the amounts and over the areas as directed.

When stipulated in the proposal, or directed by the engineer, levelling material of the kind of premixed bituminous surfacing specified shall be spread in compacted layers not to exceed two inches or a total thickness exceeding six inches, as is necessary to level irregularities, dips, depressions, sags and excessive crown and to provide a smooth base of uniform grade and in conformance to the typical section in order that the subsequent surface course or courses of bituminous surfacing shall be of uniform thickness. When such corrections exceed six inches in depth, specified aggregate surfacing material shall be used. If plant mixed bituminous surfacing is spread as the levelling material, it will be paid for at the unit price bid for plant mix bituminous surfacing and no additional allowance will be made for spreading, levelling and rolling.

16.22 EXISTING SURFACE REMOVAL. This type of work shall be accomplished by any equipment equal to the job and satisfactory to the engineer. The surface, after removal, shall be prepared to receive any new surfacing material in the same manner applicable as described in Article 16.12.

16.13 and 16.23 METHOD OF MEASUREMENT. "Existing Surface Preparation" or "Existing Surface Removal" may be measured by the mile or by the station, calculated along the centerline of the roadway, by the square yard of area or by the equipment unit hour, as stipulated in the proposal or shown in the plans. Materials or aggregates, rolling and watering required to complete "Existing Surface Preparation" will be included in the surfacing quantities.

All materials, aggregates, surfacing course aggregate, bituminous material, bituminous mixed surfacing spread as the levelling material, watering and rolling, except rolling on any

plant mix bituminous surfacing, used in the completed and accepted work for corrective purposes in "existing surface preparation" will be measured by the unit indicated in the proposal, pertinent to the class of work performed.

16.14 and 16.24 BASIS OF PAYMENT. "Existing Surface Preparation" or "Existing Surface Removal" will be paid for at the unit bid price or prices stipulated in the proposal, which prices and payment shall be full compensation for The Work. If not stipulated in the proposal, work required of "Existing Surface Preparation" or "Existing Surface Removal" will not be paid for directly but will be considered incidental to the payment for and the performance of the other items of the contract, which payment shall be full compensation for The Work. This type of work will be listed on bid proposals as "Surface Preparation" and "Surface Removal" respectively.

All materials, aggregates, surfacing course aggregate, bituminous material or bituminous mixed surfacing spread as the levelling material, watering and rolling, except rolling on any plant mix bituminous surfacing, will be paid for at the contract unit bid price, which price and payment shall be full compensation for The Work.

SUBSECTION 16.30 TRAFFIC PROVISIONS.

16.31 DESCRIPTION. "Traffic Provisions" describes and outlines methods to be employed by the contractor in providing additional safety on projects, where public traffic is required to pass through construction, when work activity is of such kind and nature as to require features of traffic safety and control more positive and extensive than those afforded by standard requirements.

Adequate flagging, directing of traffic, signing and general protection of the traveling public will be required on all projects whether or not the proposal contains an item for such work.

When "Traffic Provisions" is specified by the proposal, the contractor shall, at all times work is in progress on each section of grading, gravel surfacing or bituminous construction, furnish and have on duty a flagman equipped in the manner described herein, at each end of any such section of work over which public traffic is compelled to travel. In the instance of bituminous seal coating or bituminous treatment work a pilot vehicle, with operator, will be required in addition to the flagman. On these two types of bituminous construction the contractor also will be required to maintain flagmen and a pilot vehicle on the work for a period of twenty-four (24) hours following the placing of the freshly spread bituminous cover aggregate, unless ordered otherwise in writing.

"Traffic Provisions" will be specified in the plans and proposal by schedule or schedules according to the type of traffic safety and control required.

Schedule 1. Requires the furnishing of two flagmen and necessary signals, signs, lights and incidentals while work is in progress.

Schedule 2. Requires the furnishing of two flagmen and necessary signals, signs, pilot vehicle with operator and signs, lights and incidentals while work is in progress.

Schedule 3 Requires the furnishing of a motor vehicle and driver, or more than one if necessary, while any of the contractor's construction equipment is operating on the publicly travelled way or traffic lanes.

On any construction project "traffic protection" shall be accomplished in accordance with the methods outlined in this specification.

16.32 EQUIPMENT A N D P E R S O N N E L. Signals, Signs, Lights, Incidentals. See Standard Drawing.

(A) Hand Signal. Shall be in accordance with the provisions of Figure 1.

(B) Flagman Sign. Shall be in accordance with the provisions of Figure 2, supported by a tripod.

(C) Tripod. The tripod to hold the flagman sign shall be in accordance with the provisions of Figure 3.

(D) Vehicle Sign. The pilot car shall be equipped with a sign conforming to the provisions of Figure 4. It also shall carry a 12" x 12", or larger, brilliant red cloth mounted on left fender or cab.

(E) Lights. Flagmen on duty at night shall be stationed with a white light of sufficient brilliance to clearly outline their figures. Hand equipment for night will include a five cell red flashlight or lantern of equal brilliance. Flashing yellow or red signal lights or pot flares will be required at the "flagman" signs.

All signs and signals shall be of commercial manufacture or type and of standard kind. Letters shall be weighty in type and in proportion with letter height and sign dimension. Signs and signals with lettering shall be maintained in freshly painted and clean condition at all times.

(F) Flagman. Only a reliable person, physically active and mentally alert, shall be assigned as flagman. A flagman shall present a neat, clean appearance and shall competently and courteously direct traffic and inform drivers of conditions and restrictions on the construction work. On occasion it may also become the duty of a flagman to hand out courtesy cards, furnished by the Department, to traffic drivers. It will be the contractor's responsibility to instruct and properly supervise flagmen in their duties.

A flagman will be stationed near the edge of the oncoming traffic lane. He shall wear a bright red garment such as a shirt, vest, jacket or coat and, in addition, shall wear red reflective headgear. A hat with reflective stripes, if satisfactory to the engineer, may be used. In daylight he shall have in hand a signal as specified in Part (A) and in place a flagman sign as specified in Part (B). The flagman sign shall be displayed facing traffic, at the edge of the oncoming traffic lane five-hundred feet from the flagman. At night the sign shall be marked with a pot flare or yellow or red flashing signal. The flagman, at night, shall have at his side lighted, the illumination light of the kind described in Part (E) and in hand, instead of the hand signal, he shall have an adequate red flashlight or lantern of equal brilliance, which he shall wave in suitable fashion at oncoming drivers, for the purpose of "slowing" or "stopping" vehicles as required. A flagman shall be assigned no other duties during the time he is assigned to flag traffic.

The hand signal for daylight, and the sign used, shall be appropriate to the type of traffic control being exercised—"STOP" or "SLOW" as the case may be. If vehicles are being brought to full stop, the flagman shall hold the hand signal in outstretched right hand in such position that the signal may be easily read by approaching drivers. Immediately upon the vehicle coming to a stop the flagman shall, courteously and briefly but accurately, advise each driver of the traffic regulations in effect on the control section and give instructions to proceed accordingly.

If "SLOW" control is in effect, the flagman shall hold out the "SLOW" signal and upon the vehicle slowing satisfactorily, the flagman shall lower the signal and beckon the driver to proceed.

(G) Pilot Vehicle. The contractor shall furnish a fully operable pilot car, pickup or other suitable vehicle together with operator. A pilot car sign shall be mounted in a conspicuous position on the rear of the vehicle which is to be used to guide controlled one-way traffic through or around a road construction area. The sign shall carry the legend "Pilot Car Follow Me" in accordance with standard drawings. The pilot car shall operate at a speed compatible with the character of the work and safety of the traffic being conducted through the work. Upon reaching the end of a control section the pilot car shall stop on the extreme right side of the roadway and the operator shall wave traffic to proceed.

When traffic is being piloted over construction areas greater than three miles in length the contractor shall operate two pilot vehicles.

On certain types of work on relatively short control sections for one way traffic it will be permissible, under certain conditions, to handle traffic without the use of a pilot car. In these cases traffic will be held up on alternate ends of the section. The last car in the traffic line will carry a "baton"

from one flagman to the other which shall be the signal to the flagman receiving the "baton" that the lane is clear for the line being held up to proceed. The flagman shall not permit traffic to start until he has assured himself that the lane is clear of all oncoming vehicles.

(H) It is of top importance that flagmen, and others connected with the responsibility of traffic control, discharge the duties thereof with alertness and particular attention toward maintenance of utmost safety and protection for public traffic.

(I) When the contractor is operating construction equipment that operates along the travelled way, incidental to performance of its work, a motor vehicle and driver shall precede such equipment. If more than one vehicle or operator are necessary in the public interest, they shall be put into operation. The motor vehicle and construction equipment shall bear approved signs and warning devices similar to those described in preceding parts.

16.33 METHOD OF MEASUREMENT. Schedule 1 of Traffic Provisions will be measured by the hour for "Flagman hours."

Schedule 2 of Traffic Provisions will be measured by the hour for a combination of two flagmen and one pilot car with operator.

The operation of the motor vehicle and driver, under Schedule 3, shall be measured by the hour, allowance being made only for the time the contractor's equipment is actually working on the travelled way of the project.

When specified, but not stipulated in the proposal, Traffic Provisions will not be measured separately but shall be considered incidental and necessary to the performance of the other items of the contract.

16.34 BASIS OF PAYMENT. When stipulated in the proposal, Schedule 1 or Schedule 2 of Traffic Provisions as measured will be paid for at the unit price bid for each of the separate items specified and used in the completed and accepted work, which prices and payment for each shall be full compensation for The Work.

Operations under Schedule 3 will be paid for by the hour for each vehicle and driver, which price and payment shall include the required motor vehicles, personnel, warning devices, fuel and all other costs involved in effecting satisfactory traffic provisions and protection.

When specified, but not stipulated in the proposal, Traffic Provisions will not be paid for directly but shall be considered incidental to and included in payment for the other items of the contract.

SUBSECTION 16.40 OBLITERATE ROADWAY.

16.41 DESCRIPTION. "Obliterate roadway" shall consist of the obliteration, in accordance with these specifications of

such portions of abandoned roadways as are shown on the plans, or designated by the engineer, for obliteration and shall include the appropriate grading, scarifying, plowing and harrowing of such areas of the old roadway as directed.

16.42 CONSTRUCTION METHODS. After the old road is no longer needed for traffic the old ditches shall be filled and the roadway graded, either to approximately restore the original contour of the ground or to produce a contour that will merge with the contour of the adjoining land. Where feasible, the old ditches may be filled by blading the existing surface material into them and covering it with suitable soil. Old structures, including guard rail, not included in other bid items for removing structures shall be broken down and buried or removed, as directed. All material with salvage value shall be carefully removed and neatly piled to avoid damage.

After the rough grading is completed the area of the old road surfacing shall be scarified or plowed to effectively mix the remaining metal with earth and the entire area of the old roadway shall be harrowed and smoothed. The entire area shall be left with a smooth surface, having rounded slopes level enough to permit cultivation.

16.43 METHOD OF MEASUREMENT. The length of old roadway obliterated to be paid for will be (a) the number of miles and fractions thereof determined to the nearest one-hundredth (0.01) or be (b) the number of stations (100 feet) of roadway, measured along the centerline, obliterated as required and accepted, or be (c) the number of square yards of old roadway (or street or similar area) or (d) the number of cubic yards measured as specified by Article 11.04, obliterated as required.

16.44 BASIS OF PAYMENT. When the proposal contains an estimated quantity for "Obliterate Roadway," the number of miles, stations, square yards, or cubic yards, determined as provided above, will be paid for at the contract unit price bid for "Obliterate Roadway," which price and payment will be full compensation for The Work, except as provided in Parts (A) and (B) of this Article.

(A) Material obtained from the old roadway and used in construction of the new roadway will be paid for under Section 11, or Section 12, as the case may be.

(B) When the proposal does not contain an estimated quantity for "Obliterate Roadway," this item will not be paid for directly but shall be considered incidental to and included in payment for the other items of the contract.

SECTION 17

EROSION CONTROL

SUBSECTION 17.00 TOPSOIL.

17.01 DESCRIPTION. "Topsoil" shall consist of furnishing, excavating, hauling, depositing, spreading and preparing for seeding an approved material in accordance with the specifications. Generally, topsoil will be placed on median areas, outer separation areas and side slopes of roadway sections in conformance with the lines, grades and dimensions shown on the plans and as directed. Topsoil may be stockpiled for use on a future contract under certain circumstances.

17.02 MATERIAL. Topsoil material shall consist of a fertile, friable soil of loamy character, typical of the topsoil in the locality, and shall contain a normal amount of organic matter. It shall be reasonably free of hard dirt, clay, rocks, weeds and other materials which will prevent the formation of a suitable seed bed.

Unless otherwise stipulated, topsoil shall be obtained from sources within the bounds of the Highway and shall be removed only from the areas and locations designated on the plans or directed by the engineer. The topsoil shall be obtained from sources providing a maximum of natural or native live grass roots.

When so stipulated in the contract, topsoil shall be obtained from outside the bounds of the Highway. Unless otherwise provided, the contractor shall make his own arrangements for obtaining such topsoil and he shall pay all costs involved with royalties and any other charges, developing the source and smoothing and levelling the source after removal.

17.03 CONSTRUCTION METHODS. The subgrade within the areas to be covered with topsoil shall be completed to the lines, grades and elevations designated or shown on the plans. The subgrade surfaces shall first be shaped, trimmed and smoothed by means of a blade grader, drag or other approved equipment. Topsoil shall not be placed until the areas to be covered have been properly prepared and all construction work in the area has been completed.

Topsoil shall be placed and spread so that it will have a minimum compacted thickness of four (4) inches when finished to the lines, grades and locations designated or shown on the plans. After the spreading of the topsoil, all large stiff clods, hard lumps, large stones, brush, roots (other than native grass roots), stumps, litter or other foreign material shall be raked up and removed from the topsoil area and the topsoil shall be keyed into the underlying soil by four complete discings with a weighted disc harrow set straight. If the topsoil is not satisfactorily pulverized beneath the surface, working of the soil

shall be continued with a disc harrow, tooth harrow or a corrugated roller until the desired condition is obtained. Spreading shall be completed in such a manner that seeding, or planting, can proceed after completion of this item without additional soil preparation of any nature.

Acceptable topsoil material encountered in roadway excavation work may be deposited (a) in uniform windrows along the tops of excavation slopes, in the amounts specified or directed, (b) in such a manner that it can be uniformly spread over the slopes or (c) in convenient stockpiles for spreading in areas designated on the plans, or as directed, or for use in a future contract.

17.04 METHOD OF MEASUREMENT. Topsoil will be measured by the cubic yard in the hauling vehicle at the point of delivery at the area where it is to be placed or at the stockpile site. In order to aid checking of loads, the contractor shall strike off or level any load when required.

When necessary to remove any material such as rock, hard dirt, clay, weeds, roots, or any other deleterious matter from the topsoil after placing, the amount of such material will be measured by the cubic yard, returned to the topsoil source and it will be deducted from the total amount of topsoil placed.

17.05 BASIS OF PAYMENT. Topsoil used in the completed and accepted work will be paid for at the contract unit bid price which price and payment will include furnishing royalties unless otherwise stipulated, loading, hauling, placing, pulverizing, spreading, shaping, watering, smoothing, rolling, finishing and for all other charges; for maintenance of the completed surface until acceptance and for everything necessary to complete The Work.

SUBSECTION 17.10 SEEDING AND FERTILIZING.

17.11 DESCRIPTION. Seeding and fertilizing shall consist of ground surface preparation, furnishing and application of fertilizer, furnishing and planting seed of designated species or variety on shoulders, slopes, borrow areas, and other areas designated or shown on the plans, in accordance with the specifications. Cleanup and finishing is included.

17.12 MATERIALS. (A) Grass Seed. All seed shall be of a good standard grade, adapted to Montana conditions, and shall comply with, and be labeled in accordance with, applicable State and Federal seed laws. Seed shall have been grown at a source no farther south than the south border line of the State of Wyoming. All kinds of seeds, even when specified for mixing, shall be furnished and delivered separately packaged or bagged. Before any seed is planted, the engineer shall be furnished a purity analysis and germination test of the seed proposed for use. The germination test shall have been made no more than nine months prior to the seeding date. The kind,

quantity and other information concerning the seed shall be as set forth in special provisions. Seed shall be applied on the "live seed" basis. The amount of "live seed" in a 100 pound container will be determined by the formula: 100 multiplied by germination percentage multiplied by purity percentage. (If the seed is 85% pure and tests 90% germination, then a 100 pound container would contain 76.5 pounds of "live seed.") Noxious and other weed seed content shall not exceed limits set by Montana seed laws. Seed which has become wet, moldy, or otherwise damaged in transit or storage will not be acceptable.

(B) Legume Seed. Source, grade, purity, germination and "live seed definition" for legume seed shall be the same as for grass seed. When legumes are seeded, inoculants specified by the special provisions shall be used.

(C) Fertilizer. Fertilizer shall be a soluble commercial carrier of available plant food element or combination thereof. The fertilizer to be used on the project shall supply the quantities of available chemical elements stipulated in the special provisions. The fertilizer shall be uniform in composition and in good condition for application by suitable equipment. It shall be labeled with the manufacturer's guaranteed analysis as governed by applicable fertilizer laws. Any fertilizer which becomes contaminated or damaged, making it unsuitable for use, will not be accepted.

(D) Water. Water used for seeding shall be of irrigation quality, free of alkali or impurities that would be detrimental to plant growth.

ARTICLE 17.13 CONSTRUCTION METHODS. **(A) Conditioning Seedbed Surface.** Areas to be seeded will have been completed, in general, to specified line and grade prior to seeding and fertilizing. Areas having a substantial and satisfactory growth of native grasses, or substantial areas, such as solid rock, where grass cannot grow, are not to be seeded or fertilized. It is necessary, in so far as it is practicable and feasible, as shall be determined by the engineer, that the seedbed surface, at the time of application of seeds, be reasonably free of large lumps, clods, and impervious crusts of dirt; that there be no appreciable areas of loose soils which can feasibly be compacted; that the surface, to a depth of approximately two inches, not be so tightly compacted that seed cannot begin growth. The contractor shall treat such areas, as shall be directed by the engineer, to attain, as nearly as is practicable, the condition described above. He shall use such equipment as will assure as good a seedbed as is practicable.

Areas on which there is a protective cover of dead vegetation, whether weeds or grains, need not be conditioned prior to seeding. When there is a stand of cheat grass, or similar noxious vegetation, it shall be eradicated or destroyed prior to seeding. Live vegetation, which provides a protective cover,

shall be mowed and removed prior to seeding if its presence will prevent good planting practice; if good seeding can be attained with the vegetation standing, it shall then be mowed and left lay after seeding. Mowing shall be done, where terrain permits, with equipment using a cutting blade which rotates in a plane parallel to the ground. Whether the vegetation is live or dead, if it will prevent good seeding practice, it shall be removed. Vegetation that has matured and lost its leaves need not be mowed.

Areas on a slope steeper than 3:1, which are bare or practically devoid of vegetation and which cannot practicably be seeded by drill, shall be conditioned prior to seeding if the surface is hard, slick or crusted to the extent that seeds broadcast or blown onto the area cannot penetrate the soil. If the area is wet and soft on the surface when seeding is done, conditioning will not be required. Gravelly or rocky slopes shall not be "conditioned" prior to seeding; the same applies to soils predominately sandy and easily erodeable. Areas where the slope is steeper than 3:1 and which are interspersed with alligator cracks and crevices into which seeds may fall and start growth need not be "conditioned." Roadway inslopes and backslopes which lie on a slope of 3:1 or steeper shall not, in general, be conditioned prior to or after seeding unless specifically ordered by the engineer. The use of disk, harrow, cultipacker or other equipment will be permitted if it will give satisfactory results. When seeds are applied by drill, harrowing or disking will not be required unless the soil surface is so hard that the drill will not properly penetrate the soil. Any and all hand labor required in seedbed preparation shall be included in the price bid for the work described herein. The work described herein shall be bid as "Condition Seedbed Surface." The final quantity may vary from zero to several hours, dependent upon conditions at time of seeding.

(B) Seed Distribution. (1) General. Seed shall be applied to the seedbed by the methods described herein not more than 48 hours after seedbed surface conditioning. Seed shall be planted by drill on all areas lying on a slope of 3:1 or flatter, if the area is large enough to permit operation of a drill and unless specified otherwise. When the ground texture is such (e.g. gravelly or rocky) that a drill cannot properly function, then Method (B-3) or (B-4) will be used. Areas which lie on a slope steeper than 3:1 but which are essentially a part of an area being planted by drill and which can be seeded, practicably, by drill shall be so seeded. Inslopes and narrow median areas may be planted by hydroblower rather than drill. Seeding by Methods (B-3) and (B-4) shall not be performed when the weather is adverse to obtaining good results. When the ground is thoroughly wet to such a depth that seeding by drill cannot be accomplished within specified dates, then seeding Method (B-4) will be performed. The seed, when finally applied, and regardless of method, shall not be covered by soil more than one-half inch. Seed shall be applied at the basic

rates set forth in the special provisions or as shown by the plans.

(2) Seeding by Drill. Seed may be applied by a grain drill or a seeder especially designed or modified for grass seed. When a grain drill is used, it must be specially equipped for grass seeding. Any such equipment must satisfactorily regulate the depth of planting, by such device as depth bands or coulters, and the rate of application. The seed shall be uniformly distributed in the drill hoppers to assure a uniform application of the various species. The seed shall be drilled in rows not more than eight inches apart, running normal to the slope of the ground (approximately horizontal). A drill wider than eight feet will not be permitted.

(3) Broadcast Seeding. Seeding by hand broadcasting will be permitted in small inaccessible areas only. A mechanical broadcaster may be used when approved by the engineer, and then only in areas impractical to cover by other prescribed methods.

(4) Seeding by Hydroblower. Seed, fertilizer and water shall be combined to form a mixture and applied to the specified surface by power sprayer, blower or similar equipment. The equipment shall be so designed and operated as to provide a uniform mixture, obtaining the correct seed, fertilizer and water ratio from start to finish of each batch. The mixture shall be applied to the seedbed in less than two hours after fertilizer, if any, has been added to it.

(C) Application of Fertilizer. When seed is applied by Method (B-3), the fertilizer shall be applied separately from the seed and mixed into the soil by disk or harrow or hand methods. When Method (B-4) is used, fertilizer may be applied with the seed. When Method (B-2) is used the fertilizer shall not be mixed with the seed but may be applied in the same operation from a compartment separated from the seed.

(D) Finishing. When seeding is done by Method (B-2), the seedbed shall be compacted by an agricultural roller, cultipacker or compacter not more than 24 hours after seeding. However, compacting will not be required where a roller-type grass seeder has been used. Time for compacting will be added to that described in 17.13 (A).

(E) Seeding Dates. All seeding shall be done between the dates of October 15 and April 30, unless stipulated otherwise in the special provisions or in writing.

(F) General. Existing structures and facilities shall be adequately protected and any damage done by the contractor shall be repaired or adjusted to the satisfaction of the engineer.

17.14 METHODS OF MEASUREMENT. (A) "Grass Seeding" will be measured by the pound of live seed applied to the

seedbed. Application of an amount more than 10% above that quantity authorized in writing will not be measured for payment.

(B) "Fertilizing" will be measured by the ton of 2,000 pounds.

(C) "Condition Seedbed Surface" will be measured by the actual hours of equipment work on the seedbed surface, both preparation and finishing.

(D) Water used in application of seed will not be measured for payment.

17.15 BASIS OF PAYMENT. (A) Seeding will be paid for at the unit bid price, which price and payment shall be full compensation for furnishing all seed, hauling, planting, spreading, and for all other attendant operations necessary to complete the work.

(B) Fertilizing will be paid for at the contract unit price bid for fertilizer, which price and payment shall be full compensation for furnishing all materials and completing the work as specified.

(C) "Conditioning Seedbed Surface" will be paid for at the price bid per hour, which price and payment shall include all costs involved in the use and operation of such equipment for both preparation and finishing.

SUBSECTION 17.20 MULCHING.

17.21 DESCRIPTION. "Mulching" shall consist of covering and processing specified areas, seeded or to be seeded, with a mulch of the stipulated materials.

17.22 MATERIALS. (A) Mulching materials used on the project shall be those stipulated as bid items in the proposal form and described in the succeeding parts of this Article.

(B) **Vegetative Mulch.** This type of mulch material shall be composed of wheat straw, rye straw or grass hay, in that order of preference. Chopped or ground material is not acceptable. It shall be free of musty, moldy, or rotted hay or straw; free of seed-bearing stalks of noxious weeds or grasses; free of stones, dirt, roots, stumps or other fallen material. This mulch will not be acceptable if it contains more than 50% moisture; any moisture content in excess of 15% will not be eligible for payment. (See Article 17.24). Moisture content will be determined by drying representative samples to a constant weight at 220°F. SS-1 Emulsified Asphalt shall be used as a binder for this type of mulch, unless otherwise directed.

(C) **Bituminous Mulch.** This type of mulch shall be SS-1 Emulsified Asphalt as specified in Section 30 Bituminous Materials. Its chemical composition must be such that it will be

non-toxic to plant life. Loading and application temperature shall be not less than 50°F.

(D) Fabricated Mulch. Fabricated mulch shall be made up of jute, burlap, or kraft paper string in a manner and of such design as is approved by the engineer. Samples shall be submitted to the laboratory, if necessary, before use. It shall be a material made and commonly used for the purpose of preventing erosion of soil surfaces.

(E) Fabricated Netting. Fabricated netting shall be made up of jute, burlap, kraft paper string or similar products. It may be made up on the project or prefabricated. Its purpose will be to hold vegetative mulch in place, against wind erosion and similar action, until a plant growth is attained. The proposed material must be approved prior to use and, if required, samples submitted to the laboratory. It shall be installed only where needed to prevent wind erosion as directed by the engineer.

17.23 CONSTRUCTION METHODS. **(A) General.** Mulch as described in 17.23 (B) or (C), when required, must be applied to seeded areas not more than 24 hours after seeding, regardless of the type used, unless the ground is wet; application then must be made before the ground is dry. Mulch shall not be applied to areas having a substantial vegetative growth, such as grasses, weeds and grains. Mulching shall not be done during adverse weather conditions or when wind prevents uniform distribution. Application, if after seeding, shall be in such manner as to not seriously disturb the seedbed surface. All roadway structures and facilities shall be protected and kept undamaged from application of bituminous material and other operations. Any such material deposited on such structures or facilities shall be removed to the satisfaction of the engineer.

(B) Application of Vegetative Mulch. Vegetative mulch may be applied prior to seeding or after seeding as directed by the engineer. The mulch shall be applied to the seedbed surface at the approximate rate of one and one-half tons per acre, the intent being to secure 1½ to 2 inches of loose cover. Application may be done by any means satisfactory to the engineer. If bituminous material has not been used as a binder, the vegetative material shall be fastened to the ground by strings and wooden pegs or metal pins, fabricated netting, by shovels-full of dirt, or such means as are satisfactory to the engineer. If the bituminous material is not adequate, in some cases, in preventing movement of the mulch, then the fastening methods described in the preceding sentence shall be used.

(C) Application of Bituminous Mulch. **(1)** When asphalt emulsion is the only mulch material stipulated in the proposal form or plans, it shall be applied at a rate of approximately two-tenths (0.2) gallon per square yard (1000 gallons per acre) by blowing or other means that will not disturb the seedbed surface. It shall not be applied prior to seeding. It

shall be applied at such a rate that it will not cause surface erosion. It must not be applied in such quantity as to completely blanket the ground surface. It shall be applied only to slopes steeper than 3:1, excepting that, in cut sections, the inslope shall be included if the backslope is so treated. Inadvertant spillage onto flatter slopes between the blowing equipment and the designated slope will be permitted but must be held to a minimum.

(2) When asphalt emulsion is added to vegetative mulch, as a binder, by an approved blower or similar means, it shall be applied at the approximate rate of two hundred gallons per one and one-half tons of vegetative material. This quantity shall be subject to increase or decrease due to wind condition and the location of the area being mulched. The bituminous and vegetative materials shall be uniformly mixed together, mechanically, immediately prior to or during application to the seedbed surface.

(D) **Application of Fabricated Mulch and Fabricated Netting.** Fabricated mulch shall be laid on the areas specified by the plans or directed by the engineer and securely fastened to the ground by wire staples, wooden pegs or other satisfactory devices. Application shall be after seeding.

(E) **Finishing.** Prior to final acceptance of the project, the contractor shall immediately remulch any area from which the original mulch may have been washed or blown. If the original seedbed and seeding is damaged due to the displacement of the mulching material, the seedbed shall be repaired and reseeded before remulching. The operations described in this paragraph shall be at the contractor's expense if the damage is due to his negligence.

17.24 METHODS OF MEASUREMENT. (A) **Vegetative Mulch.** This material shall be measured by the ton of 2,000 pounds, furnished and placed on the seedbed. If the material contains, at the time of weighing, more than 50% moisture, it will be rejected. If the material contains less than 50% and more than 15% moisture, then a correction in pay quantity will be made. The weight eligible for payment, W, is computed from the following formula:

$$W = \frac{G \times (100-M)}{10,000} \times (100+P) \quad \text{in which}$$

G = gross weight of the mulching material

M = percent of moisture in mulching material (to nearest 0.5%)

P = percent of moisture permitted in net weight to be paid for

(B) **Bituminous Mulch.** Bituminous material, used for mulching purposes, whether alone or with vegetative mulch,

will be measured by the gallon corrected to a temperature of 60°F.

(C) Fabricated Mulch. Fabricated mulch will be measured by the square yard in place and accepted. The stipulated quantity is placed in the proposal to obtain a price and may be considerably more or less in final quantity.

(D) Fabricated Netting. Fabricated netting will be measured by the square yard, in place and accepted. The stipulated quantity is placed in the proposal to obtain a price and may be considerably more or less in final quantity.

17.25 BASIS OF PAYMENT. Vegetative material, bituminous material, fabricated netting and fabricated mulch will be paid for at the contract unit bid price, which price and payment shall be full compensation for furnishing and applying to the seedbed surface said materials in conformance with the specifications and plans.

SECTION 20

AGGREGATE SURFACING

GENERAL CONDITIONS

20.01 DESCRIPTION. This specification determines the general requirements of the various types of aggregate materials used as surfacing, kinds of equipment, production methods, construction methods, surface smoothness, and other provisions concerning all aggregate surfacing.

The specific type and grading of aggregate surfacing will be indicated on the plans or in the proposal, which types and gradings are described in subsequent sections of these specifications.

20.02 MATERIALS. (A) Aggregate surfacing materials shall be obtained from acceptable sources which may be indicated on the plans or described in the proposal or from authorized supplementary acceptable sources selected under the direction of the engineer. All aggregate surfacing materials shall be free from vegetable matter, balls of clay, frozen lumps or other extraneous matter and shall conform to the specifications as detailed in subsequent sections for the particular type and grading stipulated in the proposal or shown on the plans. The contractor shall use reasonable care in the selection of material in a pit so that a uniform product will be produced at all times. Unless otherwise specified, no compensation will be allowed for such stripping of the pit as may be required in order that satisfactory aggregate material may be secured.

Preliminary acceptance of all aggregates proposed for use in any type of surfacing, based only on those tests that can be performed in field offices, may be made at the point of production. Final and complete acceptance will be made only after review of the reports of tests that must be accomplished in the central laboratory or elsewhere. Acceptance of aggregates produced for mixing or blending with other materials will be based upon the same conditions set forth in the two preceding sentences.

Attention is directed to Article 06.01 which pertains to sources of materials.

(B) **Binder.** All the requirements of Section 26, shall be complied with when such material, in addition to that naturally present in any type of aggregate surfacing material, is required for satisfactory bonding and gradation prerequisites.

(C) Sources of surfacing materials shall be furnished by the contractor, unless otherwise specified. Should the contractor elect to produce these surfacing materials from Commission controlled source or sources, he may do so at no cost or royalty.

20.03 EQUIPMENT. **(A) Crushing Equipment.** Crushers shall have capacity to break rock fragments or boulders passing a screen with ten (10) inch square openings. Crushing plant screening equipment shall be fitted, when required, with blowers or other devices capable of removing excess and undesirable fines.

(B) Aggregate Spreader. The equipment used for spreading the aggregate or surfacing material must be of a type approved by the engineer. If a mechanical spreader is to be used, it shall be capable of spreading one-half the width of the course at one time to a specified depth, providing the total width is not over 28 feet. The spreader need not be able to spread more than a 14 foot width.

(C) Screening Plants. Screening plants shall consist of a revolving trommel screen, shaker screen, vibrating screen, or other devices capable of removing oversize material, excess and undesirable fines.

(D) Motor Graders. Motor graders may be either self-propelled motor graders, weighing not less than twenty-thousand (20,000) pounds or pull-type graders with a wheel base not less than eighteen (18) feet. All graders shall be rubber-tired, equipped with moldboards not less than twelve (12) feet in length and shall have tractive power adequate to the efficiency of their assigned operation. If track type tractors are used, the tracks shall be equipped with either rubber or smooth metal plate treads and these tractors shall not be permitted to turn on the newly completed work at any time. Units equipped with scarifiers shall have the scarifiers so constructed as to provide positive adjustment of the scarifier depth.

(E) Rollers. Rollers shall meet requirements for the particular class of work designated in Section 14.

(F) Scales. Scales, when required, shall be furnished by and at the expense of the contractor. They shall be satisfactory to the engineer and shall be tested and sealed at the expense of the contractor prior to their use on the Project and as often thereafter as the engineer may consider necessary to insure their accuracy.

When measured by the ton, the material shall be weighed on scales of a type capable of weighing complete loads in an unbroken operation. The recording devices of the scales shall be housed in a suitable manner and the scales shall be so located as to facilitate accurate weighing of loads. The scales shall be accurate to one-half of one percent at any weight.

(G) Field Laboratory. Unless specified otherwise, this shall be provided in accordance with Article 05.08.

20.04 PRODUCTION METHODS. Except as may be otherwise specified, the intention of this specification is to provide for crushed gravel, crushed rock surfacing, cover material or stone chips containing as large a proportion as possible of crushed aggregate. The entire volume of oversize material in the source

shall be passed through the various crushing or reduction units until such oversize has been reduced to the sizes specified. Oversize material retained on a screen having 10-inch square openings may be rejected. The crushed material should be combined with the screened material in such a manner that a composite product will be obtained. No surfacing material will be accepted which is loaded into hauling units in a segregated condition or which does not conform to the required grading. In case the material deposit contains sand or other material, in excess of the specification gradation requirements, or of an unacceptable quality, such excess or undesirable material shall be removed and disposed of prior to crushing, or during screening operations if crushing is not required. When production is from sources made available by The Commission, material rejected in the manufacture of surfacing aggregate shall be disposed of as directed and will remain the property of The Commission.

20.05 CONSTRUCTION METHODS. (A) Surface Preparation. When the surfacing material is to be placed on a roadbed previously completed under a separate contract, the existing roadway surface shall be prepared in accordance with the requirements of Subsection 16.10, immediately prior to placing any new surfacing under the current contract.

In the case of surfacing material being included in a contract involving grading and aggregate surfacing construction, existing surface preparation shall be performed and in conformance with the provisions of that contract.

(B) Placing. No surfacing material shall be placed upon a frozen, wet, muddy, or rutted surface, subgrade or gravel, unless otherwise directed. At least one mile of finished and accepted earth graded roadway or completely finished surfacing course shall be kept in advance of the placing of any initial or subsequent surfacing course. Depositing and spreading of the material on the prepared subgrade or existing surface or on a completed surfacing course shall commence at a point on the roadway farthest from the loading source, unless otherwise directed, and shall progress continuously without breaks. The material shall be deposited upon the subgrade or preceding course of material in such uniform manner, approved by the engineer, as to insure the ultimate planned thickness of the course being placed, following its final spreading and compaction. The material in any surfacing course shall be mixed and placed in horizontal layers of not more than four inches compacted thickness. With the exception that, when the specified aggregate is of maximum size greater than four inches, that increased size will govern. The material shall be deposited and spread in a uniform layer, with no segregation of size, to such loose depth that when compacted, making due allowances for any filler that is to be blended on the road, the layer shall have the required thickness. After the material is deposited and spread upon the roadway it shall be thoroughly mixed with a blade grader, of the type specified, to the full depth of

the layer, by blading all the material for the layer entirely across the roadway into a windrow before its final spreading is begun. When directed, the material shall be watered during the process of mixing. Each layer of material, after mixing to uniform gradation, shall be spread smooth without segregation of size to conformance with the typical section shown on the plans and thoroughly compacted by rolling, supplemented by watering, if directed, before the succeeding layer is placed.

Aggregate spreaders conforming to Article 20.03(B) or other equipment performing a satisfactory spreading job may be used, subject to the approval of the engineer. Any equipment that does not produce a uniform gradation of material for the entire width and thickness must be corrected or removed from the work. The aggregate may be watered to optimum moisture content prior to or after crushing and loading in conveyance vehicles. If the engineer decides that the gradation of the material or the moisture content, or both, provides a material that cannot be uniformly spread by a mechanical spreader, the use of the spreader shall be discontinued. The spreader shall not apply courses exceeding four inches compacted and the final courses must be equal in width and thickness to the dimensions shown on the plans.

The end results specified in preceding paragraphs shall be attained regardless of methods used in placing and compacting.

(C) Binder. The operation of blending binder shall be performed in accordance with Section 26.

(D) Watering. Prior to and during the mixing operations, if directed, water shall be added to the material in such quantities that the entire mass, during mixing, is wetted to such an extent as to prevent segregation of fine and coarse materials. Any watering shall be performed in accordance with Section 15 or the next paragraph.

The aggregate may be watered to optimum moisture prior to, or during, or after, crushing. The water used for this purpose will be paid for in accordance with Section 15. Any water deemed by the engineer to have been wasted shall not be measured for payment.

(E) Compaction. (1) Unless otherwise specified, the sub-grade and all surfacing materials shall be compacted in accordance with Section 14. When directed, watering shall be performed prior to and during rolling operations. (2) Traffic Compaction. If there is no provision for rolling stipulated in the proposal, the surfacing shall be compacted by traffic. In such case, the depositing and spreading of material on the roadway shall start at the point nearest the point of loading.

Blading or dragging, supplemented with watering when directed, shall accompany traffic compaction. The surface shall be kept free of irregularities until acceptance of The Work.

Where the traffic method of compaction is used the material shall be processed and spread as closely behind the dumping units as is practicable, but in no case shall the length of the unprocessed section exceed one-half mile.

(F) Restrictions. In addition to the restrictions imposed by State and Federal Laws on the speed, size and weight of vehicles, weight of loads and tire equipment, used in connection with the prosecution of work, the engineer may further restrict the speed of the hauling units and the weight of loads as he may find necessary to prevent damage to the previously constructed subgrade, base, surface course or courses, or public thoroughfares used in the prosecution of The Work.

20.06 SURFACE SMOOTHNESS. The surface of any aggregate surfacing material course, when finished, shall be such that when tested with a ten foot straightedge placed on the surface parallel to the centerline of the roadway, the minimum deviation of the surface from the plane of the straightedge shall nowhere exceed one-half of one inch. Should patching of any course be necessary, in order to meet such tolerances, it shall be performed by using methods approved by the engineer and using material the same as in the course being repaired. Payment for such material used for patching shall be at the unit price bid for the specified material, which payment shall be full compensation for all labor, tools, equipment and incidentals necessary to complete The Work in an acceptable manner.

20.07 METHODS OF MEASUREMENT. (A) Any aggregate material used as surfacing will be measured by the cubic yard or by the ton, for the type or types of material stipulated in the proposal. When measured by the cubic yard, measurement will be made of the loose material in the vehicle at point of delivery on the road. In order to aid checking of loads, the contractor shall strike or level any load, when directed to do so. When measured by the ton, the material shall be weighed on scales of the type prescribed in Article 20.03. When necessary to remove oversize material from the roadway, resulting from the placing of surfacing material, the amount of such oversize material will be measured by the cubic yard or by the ton, as the case may be, returned to the aggregate source and it will be deducted from the total amount of surfacing material placed on the roadway.

The weights, when measured by the ton, will be based on the scale weight of the material provided the moisture content does not exceed 5 percent. If the material contains more than 5 percent moisture, the excess over 5 percent will be deducted from the scale weight. No corrections or additions will be made to the scale weight if the aggregate contains less than 5 percent moisture. The determination of moisture content and pay weight will be made as described below.

All moisture determinations will be made on the dry basis as follows:

Weight of wet sample minus Weight of dry sample = Weight of water.

Weight of water in sample

× 100 = Percent moisture

Weight of dry sample

Measurement of pay quantities of aggregates on a ton basis, will be computed as follows when the actual moisture present at time of weighing is more than the maximum moisture content permitted:

$$\text{Pay quantity of aggregate in tons} = \frac{\text{Weight of wet aggregate in tons} \times \frac{100 + \text{allowable \% moisture}}{100 + \text{actual \% moisture}}}{}$$

(B) Rolling, Watering, Hauling and other contract items will be measured in accordance with the respective sections or subsections.

(C) "Existing Surface Preparation", when specified, will be measured by the unit or units and other items required of The Work, as stipulated in the proposal in accordance with the methods prescribed in the pertinent sections for the respective items. When not stipulated, existing surface preparation will be considered incidental and necessary to the performance of the other items of the contract.

20.08 BASIS OF PAYMENT. **(A)** Aggregate material used as surfacing incorporated into accepted work will be paid for at the contract unit bid price, which price and payment, unless otherwise specified, will include furnishing all materials, production, handling, hauling, mixing, placing and spreading all materials and for all other charges; for maintenance of the completed surface until acceptance and for all other operations necessary to complete The Work.

(B) Rolling, Watering, Hauling and other items will be paid for at the contract unit bid price in accordance with the requirements of the respective sections or subsections.

(C) "Existing Surface Preparation" will be paid for at the contract unit, or units, bid price or prices or other items required which prices and payment will constitute full compensation for The Work. Unless otherwise provided, existing surface preparation will not be paid for directly but will be considered incidental and necessary to the performance of payment for the other items of the contract.

SECTION 21

VARIOUS SURFACING TYPES

SUBSECTION 21.00 SELECTED SURFACING.

21.01 DESCRIPTION. "Selected Surfacing" shall consist of one or more courses of aggregate surfacing composed of the grade or maximum size of material stipulated in the proposal or shown on the plans, constructed on the roadway in conformity with these requirements and the specifications and plans.

21.02 MATERIALS. (A) Selected Surfacing material shall conform to Article 20.02(A), and to the particular maximum size stipulated in the proposal or shown on the plans. Pit run material shall be included.

As determined by AASHO T 11 and T 27, "Selected Surfacing" shall, for the grade specified, meet the requirements of that grade shown in the "Table of Gradations".

TABLE OF GRADATIONS

Passing	PERCENTAGES BY WEIGHT PASSING SQUARE MESH SIEVES					
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
4 Inch Sieve	100%					
3 Inch Sieve		100%				
2½ Inch Sieve			100%			
2 Inch Sieve				100%		
1½ Inch Sieve					100%	
1 Inch Sieve						100%
No. 200 Sieve less than	15%	15%	15%	15%	15%	15%

There shall be added to this table, by implication herewith, a "special grade", the details for which shall be included in the contract by special provisions. The liquid limit for the material passing the No. 40 sieve shall not be in excess of thirty (30); nor shall the plasticity index exceed six (6), as determined by AASHO T 89, T 90, and T 91. "Selected Surfacing" shall conform to any other requirements that may be stipulated in the proposal, which requirements may modify or amend these specifications, and which may be developed upon specific job conditions and/or source of material.

(B) Binder, if required, shall conform to Article 20.02(B).
21.03 to 21.08 (Inclusive) EQUIPMENT, PRODUCTION ME-

THODS, CONSTRUCTION METHODS, SURFACE SMOOTHNESS, METHODS OF MEASUREMENT AND BASIS OF PAYMENT, shall apply to the methods of production, placing, measuring and payment, of Selected Surfacing and conforming to Articles 20.02 to 20.08 (inclusive).

SUBSECTION 21.50 SAND SURFACING.

21.51 DESCRIPTION. "Sand Surfacing" shall consist of one or more courses of sand composed of material stipulated in the proposal or shown on the plans, constructed on the roadway in conformity with these requirements and the specifications and plans. In general, the sand material will be placed in one course on a newly-constructed subgrade to serve as a choke, stabilizing cushion or foundation course for subsequent surfacing of other types.

21.52 MATERIAL. (A) "Sand Surfacing" shall conform to the requirements of Article 20.02(A) and to the particular specifications for the type and size of grade stipulated in the proposal and/or shown on the plans.

As determined by AASHO T 11 and T 27, "Sand Surfacing" shall, for the grade specified, meet the requirements of that grade in the Table of Gradations.

TABLE OF GRADATIONS

Passing	PERCENTAGES BY WEIGHT PASSING SQUARE MESH SIEVES					
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
1½ Inch Sieve	100%					Special
1 Inch Sieve		100%				100%
¾ Inch Sieve			100%			-----
½ Inch Sieve				100%		-----
No. 4 Sieve					100%	-----
No. 10 Sieve						
Not less than	65%	65%	65%	50%	50%	50%
No. 200 Sieve						
Not more than	20%	20%	20%	20%	20%	10%

The liquid limit for the material passing the No. 40 sieve shall not be in excess of twenty-five (25), nor shall the plasticity index exceed zero (0), as determined by AASHO T 89, T 90 and T 91.

"Sand Surfacing" shall conform to any other requirements that may be stipulated in the proposal, which requirements may modify or amend these specifications and which may be developed upon specific job conditions or source of material.

(B) Binder, if required, shall conform to the requirements of Article 20.02(B).

21.53 CONSTRUCTION METHODS. (Supplemental). The sand material shall be deposited upon the roadway and spread with blade graders or other approved equipment in such manner as to insure the ultimate planned thickness of the layer being placed following its final spreading and compaction. The material in any sand course shall be placed in horizontal layers of not more than six (6) inches compacted thickness when directed. The sand shall be watered prior to, during and after spreading and compacted by rolling.

Immediately after placing, the sand material shall be covered with the specified surfacing in conformance with the plans and specifications. The sand material shall not be placed further than one-thousand (1,000) feet in advance of the succeeding course of surfacing.

21.54 to 21.58 (Inclusive) EQUIPMENT, PRODUCTION METHODS, CONSTRUCTION METHODS, METHODS OF MEASUREMENT AND BASIS OF PAYMENT, shall apply to the methods of production, placing (except as herein supplemented), measurement and payment of sand surfacing and conforming to, respectively, Articles 20.03, 20.04, 20.05, 20.07, and 20.08.

SECTION 22

CEMENT STABILIZED BASE COURSE

22.01 DESCRIPTION. "Cement Stabilized Base Course" shall consist of one or more courses of base surfacing composed of a combination of selected mineral aggregate and Portland cement, uniformly mixed, moistened, compacted and cured in accordance with these specifications and conforming to the lines, grades, thicknesses and typical cross section shown on the plans or as may be directed.

22.02 MATERIALS. (A) Portland Cement. Portland cement shall conform to the requirements of AASHO M 85, Type I. One sack containing one cubic foot of Portland cement shall be considered as weighing ninety-four (94) pounds net. One barrel of cement shall be considered as weighing three-hundred-seventy-six (376) pounds net and containing four cubic feet. Bulk cement may be used provided the equipment for handling, weighing and spreading is approved.

(B) Water. Water used in the construction of this base course shall be from a source approved by the engineer and shall conform to Article 46.04(B).

(C) Mineral Aggregate. The mineral aggregate shall be obtained from approved sources. It is the intent of this specification to use the material from the approved sources subject to the following stipulations:

Extreme care shall be used in removing the mineral aggregate, so that it is not contaminated with deleterious overburden or material from a lower or adjacent strata, and assuring that a uniform product is placed on the roadway.

The maximum size, the grading and the quality of the mineral aggregate shall conform to the requirements set forth in the special provisions.

Whenever the word "aggregate" alone is used hereinafter, it shall mean "mineral aggregate."

(D) Curing Seal, Bituminous Material. The curing seal shall be the grade of bituminous material specified in the proposal form and shall conform to Section 30. It shall also serve as a tack coat for the wearing surface.

(E) Blotter Material. The blotter material to be spread over the curing seal, if any is to be used, shall be specified by the special provisions.

22.03 COMPOSITION AND PROPORTIONING. **(A) Cement.** Portland cement shall be applied at the rate determined by the engineer for the particular aggregate to be used. The approximate quantity, only, is shown on the plans. No processing of the base shall be started until all tests of the base material to be used have been completed and the exact quantity of the cement required for the particular aggregate has been determined.

(B) Water. The quantity of water required shall be the amount necessary for optimum moisture content in the compacted mixture. The quantity will vary with the nature of the aggregate and will be determined by the engineer.

22.04 CONSTRUCTION METHODS. **(A) Preparation.** The previously prepared subgrade shall be firm and able to support without displacement the construction equipment and the compaction hereinafter specified. Soft or yielding subgrade shall be corrected and made stable before construction proceeds.

Any machine, combination of machines, equipment, or an approved central mixing plant may be used to produce the completed cement stabilized base course meeting the requirements for pulverization, cement distribution, water application, incorporation of materials, compaction, finishing, and for providing protection and cover, as controlled by the specifications. Regardless of what method of mixing is used or what types and combinations of mixing machines may be used, the results shall be as specified herein.

The machines and equipment used shall be in suitable operating condition and must be approved prior to use. During

construction operations, the contractor shall maintain all equipment in proper working order and adjustment and shall make any needed resetting or readjustment of the equipment, whenever required by the engineer, and if the equipment proves inadequate to obtain the results specified, such equipment shall be made adequate or other equipment shall be substituted which will obtain the specified results.

(B) Pulverizing. The mineral aggregate shall be so pulverized that, at the completion of moist-mixing, a minimum of 80 percent passes a No. 4 sieve, exclusive of gravel or stone retained thereon.

(C) Methods of Mixing. (1) Method A—Mixed in Place.
(a) The length of roadway which can be scarified and pulverized at any time shall not exceed the length which can be completed in two working days unless written permission is given by the engineer. A sufficient amount of aggregate shall be deposited and spread upon the previously prepared sub-grade to form a base of the required compacted depth shown on the plans for the full width of base course and shaped to the specified section and grade.

(b) Application of Cement. The required quantity of Portland cement shall be spread uniformly in an approved manner. Spreading of Portland cement shall be subject to the following restrictions: (The term "cement mixture" used herein shall mean "mixture of cement, mineral aggregate and water").

Only such cement shall be applied as can be completely processed, exclusive of final surface finishing, within six (6) hours after the addition of cement; however, surface finishing must be completed during daylight hours.

No cement shall be applied when the moisture content of the loose aggregate exceeds by more than two percent the specified optimum for the aggregate cement mixture or when the moisture content of the aggregate will not permit a uniform and intimate mixture with the cement.

No cement shall be applied until the subgrade is capable of withstanding, without displacement, the compaction specified for the cement mixture.

No equipment, except that used in spreading and mixing, will be allowed to pass over the freshly spread cement. Any equipment traveling over the spread cement shall be maintained at slow speed and any cement displaced shall be replaced before mixing is started.

No cement shall be applied during periods of high winds which may occasion the loss of cement unless the contractor provides equipment capable of drilling the cement into the aggregate without loss.

(c) Mixing. Immediately after the cement has been distributed it shall be mixed with the loose aggregate for the full

depth of treatment. Care must be exercised that no cement is mixed below the desired depth. Mixing shall be continued until a uniform and intimate mix of aggregate and cement is obtained. Any mixture of aggregate and cement that has not been compacted and finished shall not remain undisturbed for more than thirty minutes.

(d) Application of Water. Water supply and equipment shall be provided which will permit the continuous application of water on the section being processed. A portion of the water may be incorporated in the aggregate base course prior to addition of the cement. Immediately after mixing of the aggregate and cement is complete, the moisture content of the cement mixture shall be determined by the engineer and, if required, water shall be applied uniformly in such quantities and at such a rate as he may direct. Each application of water shall be partially incorporated by the equipment, specified hereinbefore, so as to avoid concentration of water near the surface. After the last application of water, mixing shall be continued by using sufficient equipment to distribute the water uniformly throughout the full depth of the mixture in one operation. Particular care shall be exercised to insure satisfactory moisture distribution along the edges of the section. A final moisture density test will be made on samples of the moistened aggregate-cement mixture from the roadway to determine final moisture and density requirements. When this mixing operation is completed, the amount of moisture in the mixture shall not vary from the specified optimum amount by more than ten percent.

(2) Method B—Central Plant Mixed. The aggregate, cement and water shall be mixed in a pugmill, either of the batch or continuous-flow type. The plant shall be equipped with feeding and metering devices which will add the aggregate, cement and water into the mixer in the specified quantities. Dry aggregate and cement shall be mixed sufficiently to prevent cement balls from forming when water is added. Mixing shall continue until a uniform and intimate mixture of aggregate, cement and water is obtained.

The mixture shall be hauled to the roadway in trucks equipped with protective covers. The mixture shall be placed on the moistened subgrade in a uniform layer by an approved spreader or spreaders. The use of any type of spreading or mixing equipment that will not result in a mixture of uniform density for its entire depth, immediately prior to compaction, will not be permitted. Not more than 30 minutes shall elapse between the placement of cement-stabilized mixture in adjacent lanes at any location except longitudinal construction joints. The mixture shall be uniform in thickness and surface contour, and in such quantity that the completed base will conform to the required grade and cross-section. Dumping of the mixture in piles or windrows upon the subgrade will not be permitted.

Not more than 60 minutes shall elapse between the start of moist mixing and the start of compaction of cement-stabilized mixture.

(D) Moisture-Density Tests. The moisture and density relationship shall be determined by AASHO T 134. The density to be obtained in the base under the specifications shall not be less than ninety-six (96) percent of the maximum dry density as determined above.

(E) Compaction. The choice of equipment for compaction is left to the contractor; however, if any equipment proves inadequate to obtain the results specified, such equipment shall be made adequate or other equipment shall be substituted which will obtain the specified results. Immediately prior to the beginning of compaction the mixture shall be thoroughly loosened for its full depth. The loose mixture shall then be uniformly and continuously compacted until the entire width and depth of the cement stabilized base, in the lane being processed, is compacted to the density specified in Part (D) above. Compaction shall be accomplished within two hours after mixing is completed. If the compaction is less than that specified, two additional determinations will be made in the section and the results averaged. Should the average of the three determinations fail to meet the requirements, the section shall be reconstructed, at the contractor's expense, in accordance with the following schedule:

For a section reprocessed the same day as originally constructed, add 4 percentage points of additional or 50 percent of the original cement content, whichever is greater.

For a section reprocessed the day following original construction, add 75 percent of the original cement content.

For a section reprocessed after more than one day has elapsed since original construction, add 100 percent of original cement content.

(F) Finishing. After the cement-stabilized mixture is compacted, the surface of the base shall be reshaped to the required lines, grades, and cross sections and then shall be lightly scarified by means of a harrow, nail-drag or other approved equipment until a uniform even surface mulch of approximately one inch thickness is obtained. The scarifying shall, at all times, be deep enough to reach the bottom of all ruts and depressions resulting from the compaction. The surface then shall be thoroughly rolled with steel-wheeled or pneumatic-tired rollers. A motor patrol shall then tight blade the surface wasting the cuttings. Rolling shall continue until all rutting ceases and until the upper surface of the base conforms to the density requirements specified above. During compaction of the surface, the mulch shall be moistened sufficiently to insure proper compaction and a closely knit surface. The surface finishing shall be completed within two hours after the completion of the compaction specified above.

(G) Construction Joints. A straight transverse construction joint shall be formed at the end of each day's construction by cutting back into the completed work to form a true vertical face. When the width of the machine, or machines, is less than the width of the roadway lane being processed, the work shall be carried forward in successive increments so the lane may be compacted and finished for the full width in one operation, and the end of each day's run will be in a single straight line at right angles to the centerline of the roadway. Widths of base construction lanes shall be approved by the engineer in order to expedite the movement of traffic during construction. The longitudinal joint for the construction lane shall be formed by cutting back into the completed work to form a true vertical face, free of loose and shattered material. Any finished portion of the base course, adjacent to construction, which is traveled by equipment used in constructing an adjoining section shall be protected in such a manner as to prevent equipment from marring or damaging the completed work.

22.05 GENERAL REQUIREMENTS. (A) Construction Limitations. Cement shall be applied only to such an area that all operations specified can be continuous and can be completed during daylight hours. When any of these operations, after the application of cement, are interrupted for more than two hours for any reason, or when the uncompacted cement mixture is wetted by rain so that the average moisture content during compaction exceeds the tolerance specified by Article 22.34 (C) (1) (d) the entire section shall be reconstructed in accordance with these specifications, except that the quantity of cement to be added to the previously processed cement mixture shall be fifty percent of the amount originally specified. The contractor shall receive no additional compensation for such reconstruction, or for the additional cement required.

If the mixture of aggregate, cement and water is mixed at a central plant and transported to the roadway in trucks, or similar equipment, the vehicles shall be adequately equipped with tarps or covers to prevent drying of the mixture.

(B) Weather Limitations. No cement stabilization work shall be carried on during the season of probable freezing temperatures. No cement shall be applied unless the temperature is at least 40° F. and rising.

(C) Surface Smoothness. The surface of the cement stabilized base course shall be such that, when tested with a ten foot straightedge placed on the surface parallel to the roadway center line, the maximum deviation of the surface from the edge of the straightedge shall nowhere exceed three-eighths of an inch. Patching of the surface will not be permitted. After compaction and finishing has been completed, and no later than the beginning of the next calendar day after the construction of each section of base, surface irregularities not conforming to the requirements specified above shall be immediately corrected with a blade adjusted to the lightest cut and the

material removed shall be wasted on the shoulders. If practicable, these operations shall be done at the end of each day's work.

(D) Thickness. The thickness of the finished cement stabilized base course will be determined from measurements taken in test holes drilled at intervals not to exceed five-hundred feet. The average thickness of base constructed during one day shall be within one-half inch of the thickness shown on the plans, and the thickness at any one place shall not vary more than three-fourths of an inch from that shown on the plans. Where the average thickness shown by the measurements made in one day's construction is not within the tolerance given above or limited areas vary in excess of three-fourths of an inch from the plan thickness, the contractor shall reconstruct the day's work or the deficient areas, as the case may be. No extra compensation will be allowed for this reconstruction.

(E) Protection and Curing. Immediately after the operations set forth in Parts (C) and (D) have been completed, the base shall be covered and protected against rapid drying with an application of curing seal. See Article 22.32(D). The curing seal shall be applied at a rate of approximately two-tenths gallon per square yard and covered with blotter material, as specified in Article 22.32(E) at a rate of approximately fifteen pounds per square yard. The exact rate of application of the curing seal and the blotter material shall be as directed to give complete coverage without excessive run-off. The surface of the base shall be kept continuously damp between the time of the final completed compaction and the application of the curing seal.

At the time of the application of the curing seal, the surface of the base shall be tightly knit, free of all loose material, and shall contain sufficient moisture to prevent penetration of the asphalt. If necessary to insure this, sufficient water to fill the surface voids shall be applied immediately before the curing seal is applied. Any areas which absorb the curing seal within twenty-four hours after application shall be cleaned to hard cement stabilized base, remoistened if necessary and given an additional application of curing seal, as directed.

The application of the curing seal, together with the one application of blotter material, shall conform to the applicable provisions of Section 33.

(F) Maintenance. The contractor shall maintain the base to a true and satisfactory surface until the wearing course is placed. Should any repairs or patching be necessary they shall extend to the full depth of the base and shall be made in a manner to insure restoration of a uniform base course conforming to the requirements of the specifications.

(G) Traffic. No traffic, except that incidental to curing operations, shall be permitted on the finished base for seven

days after the base is compacted and the curing seal cover has been completed.

(H) Curing Limitations. (1) A bituminous wearing course shall not be placed until the cement stabilized base has cured at least twenty-one days after the curing seal has been applied. (2) A Portland cement concrete pavement shall not be placed until the cement stabilized base has cured at least seven days after the curing seal has been applied.

22.06 METHOD OF MEASUREMENT. **(A) Cement.** The cement to be paid for shall be the number of barrels actually incorporated in the completed and accepted cement stabilized base. If bulk cement is used, three hundred and seventy-six (376) pounds will be considered one barrel.

(B) Processing Cement Stabilized Base. The number of square yards of processing of cement stabilized base to be paid for shall be the actual number of square yards of accepted cement stabilized base, measured complete in place, including rolling.

(C) Mineral Aggregate. The mineral aggregate shall be measured by the cubic yard, loose measurement, or by the ton, either (a) in the vehicle at the point of delivery on the roadway or (b) in the vehicle when delivered at the central mixing plant. Regardless of the type or place of mixing, the mineral aggregate shall be measured, in effect, prior to the addition of cement, water or any other prescribed additive.

(D) Watering. Watering shall be measured by the number of 1,000 gallon units of water actually incorporated in the cement stabilized base course in accordance with Section 15.

(E) Curing Seal. The curing seal applied to the cement stabilized base course shall be measured by the gallon in accordance with Section 30.

(F) Blotter Material. The cover aggregate to be paid for shall be the number of tons, or number of cubic yards, of blotter material actually accepted and applied on the curing seal.

22.07 BASIS OF PAYMENT. **(A) Cement.** The accepted number of barrels of cement, measured as provided above, shall be paid for at the contract unit price bid per barrel for cement which price and payment shall be full compensation for furnishing, hauling, spreading and for all equipment, tools, labor and incidentals necessary to complete the item.

(B) Processing of Cement Stabilized Base. The accepted yardage of processing of cement stabilized base course measured as provided above shall be paid for at the contract unit price bid per square yard for processing of cement stabilized base which price and payment shall be full compensation for preparation of the roadbed; for scarifying, pulverizing and

drying the aggregate (if required), for mixing and remixing the aggregate, cement and water; for shaping and compaction of the mixture; for reconstruction of deficient sections; for finishing; for application of curing seal; for all protection, cover and maintenance of the completed stabilized base; and for all equipment, labor, tools and incidentals necessary to complete the item.

(C) Mineral Aggregate. The accepted number of cubic yards or tons of mineral aggregate, measured as provided above, shall be paid for at the contract unit price bid for mineral aggregate which price and payment shall be full compensation for The Work. No additional compensation will be allowed for stripping, removable of overburden or other work at the source necessary for obtaining acceptable mineral aggregate.

(D) Blotter Material. The accepted number of tons, or cubic yards, of blotter material, measured as provided above, shall be paid for at the contract unit price bid for blotter material.

(E) Watering. The accepted number of one-thousand (1,000) gallon units of water measured as provided above, shall be paid for at the unit contract price bid for watering, in accordance with Section 15.

(F) Curing Seal. The accepted number of gallons of curing seal, as provided above, will be paid for by the gallon or ton, in accordance with Section 30.

SECTION 23

CRUSHED BASE SURFACING

23.01 DESCRIPTION. "Crushed Base Surfacing", Type "A" or Type "B", shall consist of one or more courses of aggregate conforming to the maximum size or gradation specified by the proposal or shown on the plans, constructed on the roadway in conformity with these requirements and the specifications and plans.

23.02 MATERIAL. "Crushed Base Surfacing" shall be composed of gravel, talus rock, quarry rock, sandstone, slag, scoria, shale or other similar materials, all crushed, conforming to this specification, special provisions, and to Article 20.02. That portion of the material retained on a No. 4 sieve will be called coarse aggregate and that passing will be called fine aggregate.

As determined by AASHO T 11 and T 27, the material shall, for the maximum size or grade specified in the proposal, including any binder or filler which may have been added at the plant or on the roadway, meet the requirements of that grade in the Table of Gradations for the type concerned.

TABLE OF GRADATIONS—TYPE ‘A’

PERCENTAGES BY WEIGHT PASSING, SQUARE-MESH SIEVES		Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Passing							
4 Inch Sieve	100%						
3 Inch Sieve		100%					
2½ Inch Sieve			100%				
2 Inch Sieve				100%			
1½ Inch Sieve					100%		
1 Inch Sieve						100%	
No. 4 Sieve			All Grades 25-60%				
No. 200 Sieve							
Less Than			All Grades 12%				

TABLE OF GRADATIONS—TYPE ‘B’

PERCENTAGES BY WEIGHT PASSING, SQUARE-MESH SIEVES		Grade 1	Grade 2	Grade 3
Passing				
2 Inch Sieve	100%			
1½ Inch Sieve		100%		
1 Inch Sieve	50- 80%			100%
No. 4 Sieve	20- 50%	25- 55%	30- 60%	
No. 10 Sieve				20- 50%
No. 200 Sieve				
Less Than	8	8	8	

A tolerance of 5%, by weight, up to the next above specified gradation (5" for 4" max.) will be allowed. The produced material passing the maximum screen opening and retained on the No. 4 sieve shall be uniform in its grading between those limits within 5%.

Suitability of the aggregate for its particular use shall be determined by the final gradation required for grading, as established by the engineer, within the limits allowed in the Table for the Particular grading specified. The engineer may, when necessary to obtain a desired and uniform gradation, fix the maximum percent of fine aggregate passing the No. 4 sieve within the specified limits and the contractor will not be allowed any compensation for costs incurred in the rejection of fines or adjustments required in conforming to such established limits.

The material, from which Type “B” crushed base surfacing is to be produced, shall have a wear factor not to exceed 60 percent at 500 revolutions as determined by AASHO T 96.

That portion of the fine aggregate, as to Type "B" aggregate, passing the No. 200 sieve shall be less than sixty percent of that portion passing the 40 sieve. Dust ratio will not apply to Type "A" unless so specified.

The liquid limit for that portion of the fine aggregate passing a No. 40 sieve shall not exceed thirty (30) nor shall the plasticity index exceed six (6), as determined by AASHO T 89, T 90, and T 91. This applies to both types.

Binder, if required, shall conform to Article 20.02.

23.04 to 23.09 (Inclusive) EQUIPMENT, PRODUCTION METHODS, CONSTRUCTION METHODS, SURFACE SMOOTHNESS, METHODS OF MEASUREMENT AND BASIS OF PAYMENT, shall apply to the methods of production, placing, measurement and payment of crushed base surfacing and conforming to, respectively, Articles 20.03 to 20.08 inclusive, except as herein supplemented and modified.

SECTION 25

CRUSHED TOP SURFACING

25.01 DESCRIPTION. Types "A" and "B" "Crushed Top Surfacing" shall consist of one or more courses of aggregate surfacing composed of the type and maximum size or grade of material stipulated in the proposal or shown on the plans, constructed on the roadway in conformity with these requirements and the specifications and plans.

25.02 MATERIAL. (A) Type "A" or "B" Surfacing, shall consist of gravel or stone, crushed to the gradation specified for the type and grade, including a filler of crushed stone, sand or other finely divided mineral matter. Each type shall conform to the requirements of Article 20.02 and to the particular specifications for the type and maximum size or grade stipulated in the proposal or shown on the plans.

That portion of the material retained on a No. 4 sieve shall be classified as coarse aggregate and that portion passing a No. 4 sieve shall be classified as fine aggregate. As determined by AASHO T 11 and T 27, the composite material shall, for the grade specified for use in either type, including any binder or filler which may have been added at the plant or on the roadway, meet the requirements of that grade in the respective Table of Gradations.

(B) Binder, if required, shall conform to Article 20.02.

Suitability of the aggregate for its particular use shall be determined by the final gradation required for any type or grading, as established by the engineer, within the limits allowed in the Tables for the particular grade specified.

The engineer may, when necessary to obtain a desired and uniform gradation, fix the maximum or minimum percent of fine aggregate passing the No. 4 sieve within the specified limits and the contractor will not be allowed any compensation for costs incurred in the rejection of fines or adjustments required in conforming to such established limits.

The material, from which any type and grade is to be produced, shall have a wear factor not to exceed fifty (50) percent at five-hundred (500) revolutions, as determined by AASHO T 96 (Los Angeles Rattler Test).

25.03 TYPE "A" CRUSHED TOP SURFACING.

TABLE OF GRADATIONS

		Percentages By Weight Passing Square-Mesh Sieves				
Passing		Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
1	Inch Sieve	100%				
$\frac{3}{4}$	Inch Sieve	-----	100%			
$\frac{5}{8}$	Inch Sieve	-----	-----	100%		
$\frac{1}{2}$	Inch Sieve	-----	-----	-----	100%	
$\frac{3}{8}$	Inch Sieve	-----	-----	-----	-----	100%
No. 4	Sieve	40-70%	40-70%	40-70%	40-70%	50-80%
No. 10	Sieve	25-55%	25-55%	25-55%	25-60%	35-70%
No. 200	Sieve	2-10%	2-10%	2-10%	2-10%	2-10%

The aggregate for all grades, including any added binder or filler, shall meet the following supplemental requirements:

(1) That portion of the fine aggregate passing the No. 200 sieve shall be less than sixty (60) percent of that portion passing the No. 40 sieve.

(2) Aggregate shall be so graded within the limits given in the table that at least ten percent of the total aggregate shall pass a No. 4 sieve and be retained on a No. 10 sieve.

(3) The liquid limit for that portion of the fine aggregate passing a No. 40 sieve shall not exceed twenty-five (25) nor shall the plasticity index exceed six (6), as determined by AASHO T 89, T 90, and T 91.

(4) The composite aggregate shall be free from adherent films of clay or other matter that will prevent thorough coating with bituminous material. It shall be of such nature that the coating of bituminous material will not slough off upon contact with water.

(5) The composite aggregate to be bituminized shall not have a swell of more than fifteen percent in eight days and

shall show no cracking or disintegration when tested for volume swell and water absorption by ASTM D 915 as modified.

(6) No intermediate sizes, for cover aggregate and/or for other purposes, shall be removed from the material in the course of production, unless authorized, in writing, by the engineer.

25.04 TYPE "B" CRUSHED TOP SURFACING.

TABLE OF GRADATIONS

Percentages By Weight Passing Square-Mesh Sieves			
Passing	Grade 1	Grade 2	Grade 3
1½ Inch Sieve	100%		
1 Inch Sieve	-----	100%	
¾ Inch Sieve	-----	-----	100%
No. 4 Sieve	40-80%	40-80%	40-80%
No. 10 Sieve	25-60%	25-60%	25-60%
No. 200 Sieve	5-20%	5-20%	5-20%

The aggregate for all grades, including any added binder or filler, shall meet the following supplemental requirements:

(1) That portion of the fine aggregate passing the No. 200 sieve shall be less than two-thirds of that portion passing the No. 40 sieve.

(2) The liquid limit for that portion of the fine aggregate passing a No. 40 sieve shall not exceed thirty-five (35) while the plasticity index may vary from non-plastic to nine (9), as determined by AASHO T 89, T 90, and T 91.

25.05 to 25.10 (Inclusive) EQUIPMENT PRODUCTION METHODS, CONSTRUCTION METHODS, SURFACE SMOOTHNESS, METHODS OF MEASUREMENT AND BASIS OF PAYMENT, shall apply, except as herein supplemented and modified, to the methods of production, placing, measurement and payment of Types "A" and "B" Crushed Top Surfacing and conforming to, respectively, Articles 20.03 to 20.08 inclusive.

SECTION 26

FILLER AND BINDER

SUBSECTION 26.01 MINERAL FILLER.

26.01 DESCRIPTION. Mineral Filler shall consist of Portland cement, limestone dust or hydrated lime, from sources approved by the engineer.

26.02 MATERIAL. (A) Grading. The mineral filler shall meet the following requirements:

	Percent
Passing No. 30 sieve	100
Total Passing No. 80 sieve, not less than	95
Total Passing No. 200 sieve, not less than	65

(B) Method of Testing. Testing of mineral filler shall conform to AASHO T 37.

(C) Characteristics. The liquid limit of the mineral filler shall not exceed 25. It shall be non-plastic as determined by AASHO T 89, T 90 and T 91.

26.03 PROPORTIONING. If no provision is made to weigh the mineral filler in the weigh box at the mixing plant with the other aggregates, the proportions of mineral filler shall be determined on a weight basis and shall be measured separately from the other aggregates. After the exact proportions of mineral filler have been determined, the material may be added to the mixture at the mixing plant by volume or weight measurement. The mineral filler shall be added to the mixture in such a manner that it will be completely mixed and thoroughly and uniformly incorporated in the mixture.

26.04 METHOD OF MEASUREMENT. Mineral filler will be measured by the ton as used in the bituminous mixture.

26.05 BASIS OF PAYMENT. Mineral filler will be paid for at the unit contract price bid per ton and shall be full compensation for furnishing, hauling and incorporating the mineral filler in the bituminous mixture, as required by the engineer.

SUBSECTION 26.50 BINDER.

26.51 DESCRIPTION. "Binder" shall consist of fine natural soil particles or crusher dust, free from grass, roots, weeds, humus, or other undesirable matter. Its binding properties shall be such that, when added and blended with any type of

aggregate surfacing material, it will provide the final product with the physical structure and properties required by the particular specifications.

26.52 MATERIAL. Sources of binder will be indicated in the proposal and/or shown on the plans or designated by the engineer. The Commission will furnish this material in its original position, royalty free, to the contractor, except in cases where the material can be obtained within a distance of one-thousand (1,000) feet from the contractor's crushing or screening plant and is added at the plant. In this case, the additional binder will be considered an integral part of the surfacing material and shall be supplied by the contractor without additional cost to The Commission.

If any aggregate surfacing material is deficient in binding quality, or grading characteristics, an approved amount of binder shall be added, provided, however, that the grading of the final mixture shall not exceed the limits specified for the particular type and grading of aggregate surfacing. No binder shall be added, either upon the roadway or through the plant, until tests have been completed and the material approved for use by the Laboratory. Quantities of binder, and haul thereon, when included in the proposal form, are not guaranteed to be used or required and the Department reserves the right to increase, decrease or omit all or any part of these items and no compensation will be allowed by reason thereof.

26.53 CONSTRUCTION METHODS. Binder, when required, may be added at the plant or on the roadway. If added on the roadway, the binder shall be spread uniformly across the roadway over the loosely spread surfacing course layer in the amounts as directed. It shall then be thoroughly blended and mixed into the surfacing material by approved methods and equipment. Where the depth of the course is three inches or less, unless otherwise specified, the binder shall be processed into the entire depth. Where the depth of the course exceeds three inches, the binder shall be processed into not less than the upper three inches.

26.54 METHOD OF MEASUREMENT. (A) Binder which has been added to the surfacing material after it has been placed upon the roadway will be measured in accordance with the appropriate provisions of Article 20.07.

(B) Haul on binder will be measured in accordance with the appropriate provisions of Article 13.02.

26.55 BASIS OF PAYMENT. (A) Binder will be paid for at the contract unit bid price, which price and payment, except as otherwise expressly provided, will be full compensation for all material, labor, equipment, tools and incidentals necessary to complete the item and for all work, equipment and incidentals necessary in stripping overburden and restoring the

source from which binder has been obtained to a status satisfactory to the property owner and the engineer.

(B) Haul on binder will be paid for at the contract unit bid price, which price and payment will be full compensation for The Work.

SECTION 27

CRUSHED COVER AGGREGATE

27.01 DESCRIPTION. "Crushed Cover Aggregate" shall consist of Cover Material or Stone Chips meeting the requirements of these respective specifications and of Article 20.02. It shall either be placed on the roadway or stockpiled in conformity with the plans and specifications. When the materials specified by this section are to be placed in stockpile they will be listed under Section 28. When the materials are taken from stockpile and:

(1) Used for Bituminous Surface Treatment they will be listed under Section 33.

(2) Used for Seal Coat they will be listed under Section 36. The unit price bid under conditions (1) and (2) shall include loading, weighing, hauling and applying, complete in place.

27.02 MATERIAL. (A) Cover material shall conform to all the requirements of Type "A" Top Surfacing as set forth in Section 25, modified to meet the gradation requirements of the maximum size or grade stipulated in the proposal.

As determined by AASHO T 11 and T 27, the Cover Material shall meet the specified grading requirements of that grade in the Table of Gradations for Cover Material.

TABLE OF GRADATIONS FOR COVER MATERIAL

Percentages By Weight Passing Square-Mesh Sieves				
Passing	Grade 1	Grade 2	Grade 3	Grade 4
¾ Inch Sieve	100%			
⅝ Inch Sieve	-----	100%		
½ Inch Sieve	-----	-----	100%	
⅓ Inch Sieve	-----	-----	-----	100%
No. 4 Sieve	40-70%	9-33%	9-50%	9-50%
No. 10 Sieve	25-55%	0- 8%	0- 8%	0- 8%
No. 200 Sieve	2-10%	0- 2%	0- 2%	0- 2%

(B) Stone Chips. The material for this item shall be screenings of crushed stone or crushed aggregate. It shall consist of clean, durable fragments free from an excess of flat, elongated, soft or disintegrated pieces, clay balls or other objectionable material. Chips as produced shall have a clean, crisp appearance and be free from adherent films of clay or rock dust and shall be washed thoroughly unless otherwise provided in the proposal. The material from which stone chips are produced shall have a wear factor not to exceed fifty (50) percent at five-hundred (500) revolutions as determined by AASHO T 96 (Los Angeles Rattler Test). The abrasion test shall be run using a five-thousand (5,000) gram sample charge of material between the three-eights ($\frac{3}{8}$) inch and No. 4 sieves and an abrasive charge of eight balls.

Stone chips shall consist of the product obtained by crushing and screening material that has first been screened in such a manner that not less than ninety-five (95) percent of the material for crushing, when tested by laboratory methods, is retained on a sieve having openings one inch square.

When tested by AASHO T 11 and T 27 in conjunction with a water wash, chips shall meet the specified grading requirements of that grading in the Table of Gradations for Stone Chips.

TABLE OF GRADATIONS FOR STONE CHIPS

Percentages By Weight Passing Square-Mesh Sieves			
Passing	Grade 1	Grade 2	Grade 3
$\frac{1}{2}$ Inch Sieve	100%		
$\frac{3}{8}$ Inch Sieve	-----	100%	
No. 4 Sieve	0-20%	0-20%	100%
No. 10 Sieve	0- 2%	0- 2%	0- 2%

27.03 EQUIPMENT AND 27.04 PRODUCTION METHODS. Equipment and Production Methods for Crushed Cover Aggregate shall meet the requirements of Article 20.03 and 20.04.

27.05 CONSTRUCTION METHODS. If Crushed Cover Aggregate is to be stockpiled at designated locations, the stockpiling shall be accomplished in accordance with Section 28. If Crushed Cover Aggregate is to be placed on the roadway, the work shall be in accordance with, either Section 36, or Section 33, as the case may be.

27.06 METHOD OF MEASUREMENT. Crushed Cover Aggregate will be measured in accordance with Article 20.07.

27.07 BASIS OF PAYMENT. Cover Material or Stone Chips will be paid for at the contract unit bid price placed in the stockpile or complete in place on the roadway, as may be specified, which price and payment, unless otherwise provided, will be full compensation for The Work.

27.08 DISPOSAL OF EXCESS CRUSHED COVER AGGREGATE. See Article 09.04.

SECTION 28

STOCKPILED SURFACING AGGREGATE

28.01 DESCRIPTION. This specification provides for the production and stockpiling of any type of aggregate surfacing at the sites designated in the proposal or shown on the plans and as directed.

28.02 MATERIAL. The material shall conform to Article 20.02 and to the particular specifications for the type and grade stipulated in the proposal and shown on the plans.

28.03 EQUIPMENT. Equipment shall conform to Article 20.03.

28.04 CONSTRUCTION METHODS. The contractor shall produce and deliver and place the specified material in stockpiles at the designated sites. The stockpile sites shall be cleared of weeds, roots, stumps, rocks or any other matter which might contaminate the material. The piles shall be constructed as directed and so that they will occupy a minimum area. In no instance shall they be constructed in single tiers or in single truck dump widths. Stockpile construction shall be so planned and executed that the piles will not be less than three tiers in height with each tier not less than three feet in height. End dumping of material over the sides of the pile shall not be permitted.

28.05 METHOD OF MEASUREMENT. (A) Stockpiled material will be measured in accordance with the appropriate provisions of Article 20.07.

(B) Haul, when specified, will be measured in accordance with the appropriate provisions of Sections 12 and 13.

28.06 BASIS OF PAYMENT. (A) Stockpiled material will be paid for at the contract unit bid price, which price and payment, except as otherwise specified, will be full compensation for all materials, production, labor, equipment, tools, all manipulations and incidentals necessary to complete The Work.

(B) Haul will be paid for at the contract unit bid price in accordance with the appropriate provisions of Sections 12 and 13.

SECTION 30

BITUMINOUS MATERIALS

30.01 DESCRIPTION. This section sets forth the requirements for all types and grades of bituminous material for use in bituminous surfacing and allied purposes. All bituminous material used in the completed and accepted work shall meet the requirements for the particular type and grade stipulated in the proposal. Section 31 is functional for administrative purposes and contiguous hereto.

30.02 MATERIAL. Bituminous Materials shall conform to the following requirements except as may be herein supplemented or modified:

- (a) Asphalt Cement shall conform to AASHO M 20. See Table 30-M-20.
- (b) Cutback Asphalt, Rapid Curing Type (RC), shall conform to AASHO M 81. See Table 30-M-81.
- (c) Cutback Asphalt, Medium Curing Type (MC), shall conform to AASHO M 82. See Table 30-M-82.
- (d) Liquid Asphaltic Material, Slow Curing Type (SC), shall conform to AASHO M 141. See Table 30-M-141.
- (e) Emulsified Asphalt shall conform to AASHO M 140. See Table 30-M-140. Testing shall conform to AASHO T 49 (ASTM D 244).
- (f) Rubberized Rapid Curing Cutback Asphalt shall conform to the specifications as set forth in Table 30-LBF-T.
- (g) Catonic emulsified asphalt shall conform to the provisions set forth following Article 30.05.

All tables referred to above will be found at the end of this section.

Any other type of bituminous material, when stipulated in the proposal, shall conform to the pertinent requirements of the AASHO designation for the particular material.

ASTM D 165 shall be used in determining the percent bitumen soluble in carbon tetrachloride.

All asphalt cements and the residues from the distillation of all other bituminous materials shall be negative when tested with thirty-five (35) percent xylene in the Heptane-Xylene Equivalent Test, AASHO T 102.

Other bituminous materials of particular specification, which are not shown herein, may be developed upon requirement of the plans.

30.03 GENERAL REQUIREMENTS. **(A) Source.** The source of bituminous material shall be approved by the engineer before shipments are made to any project and the source of supply shall not be changed after work is started, unless specifically permitted by the engineer in writing. The contractor shall not order delivery of bituminous material without approval of the engineer and the engineer will not be liable for the quantity shipped and delivered.

Material delivered to a project shall maintain a uniformity of test results which shall not vary more than five (5) percent, unless a change is ordered by the engineer. When bituminous material being used in The Work meets requirements but fails to maintain the specified uniformity of test results, use of that material shall be terminated until such time as uniformity is reestablished.

(B) Sampling. Samples of bituminous materials may be taken from shipments at the source and at the point of delivery, as directed by the engineer. In no case shall any bituminous material be used until accepted by the Laboratory. Sampling shall be performed in conformance with AASHO T 40.

(C) Shipping. The supplier furnishing bituminous material shall carefully inspect each tank car or tank truck before it is loaded and ship only in clean, uncontaminated, fully insulated cars or trucks, sealed after loading by the supplier.

(D) Testing. Each car load or truck load of bituminous material ordered by a contractor must be sampled and tested before the material is used in The Work.

The Commission will, whenever practicable, make arrangements for pretesting bituminous material at the source of supply by an inspector from the State Highway Laboratory or an inspector from an approved commercial testing laboratory employed by The Commission.

The Commission representative shall have the use of laboratory facilities at the source of supply and shall be allowed the privilege of inspecting all tank cars and tank trucks and processes of refining relating to the material which is being supplied.

The Commission representative will gauge all shipments of bituminous material and issue certificates of delivery, showing type, grade and quantity of material shipped, as well as reports showing test results, when available. Each shipment shall be accompanied by a delivery certificate.

In any case where pre-testing has not been arranged for by The Commission the supplier of the bituminous material shall issue, in duplicate, certified test reports showing full compliance with the specification requirements for the designated grade of material, together with the following information: Project Number, Date of Shipment, Source of the Material,

Car or Truck Initial and Number, Destination, Gross Quantity Loaded, Loading Temperature, and Net Quantity in gallons at 60°F., or tons, whichever unit of measurement is stipulated. One certified report shall be sent to the engineer on the Project and one report to the State Laboratory at Helena. Suppliers' tests will be subject to check by the State Laboratory before the material is used.

Specifications and test procedures for bituminous material, except as herein modified, shall be in accordance with current AASHO specifications and test methods. The engineer reserves the right to adopt the latest revisions of any of the test procedures herein specified.

(E) Acceptance. Bituminous materials will be accepted on the basis of the results of tests which meet all the specified requirements, and which are made on samples selected and tested by The Commission or its authorized representative.

The engineer may permit the use of bituminous materials before completion of all tests required, provided the results of tests for materials previously furnished by the refinery have been consistently satisfactory.

Permission for use of bituminous materials before completion of all tests, as outlined herein, shall not be considered as a waiver of the right to reject materials which, upon completion of the tests, fail to meet the requirements of the specifications.

Permission for use before completion of tests, as provided herein, may be discontinued whenever the material fails to meet specification requirements. Permission for use before completion of tests will not be granted until the material being furnished again consistently satisfies specified requirements.

(F) Loading and Application Temperatures. Bituminous materials shall be applied at temperatures which will assure uniform mixing or spreading and the temperatures will be designated by the engineer. Recommended application temperature ranges for the various kinds and grades of bituminous materials are listed in the following table. Bituminous materials shall not be reheated and loaded at temperatures exceeding the maximum application temperature unless expressly permitted. Only at the refinery source may loading temperatures of not to exceed 50° F. greater than the listed maximums be used.

The following temperatures also shall apply, generally, to central plant mixes. Temperatures of mixtures produced in pug mills shall not be greater than necessary for hauling and placing and aggregate temperatures at the time of mixing shall be regulated accordingly. Aggregate temperatures shall not exceed the maximum temperature listed in the table of temperatures recommended for the bituminous material with which it is to be mixed, or 325° F., whichever is lowest. In no

case shall the aggregate be introduced into a pug mill at a temperature of more than 25° above the temperature of the bituminous material.

Type and Grade of Bitumen	Application Temperature		Type and Grade of Bitumen	Application Temperature	
	Min. °F.	Max. °F.		Min. °F.	Max. °F.
RC-0	50	125	MC-1	100	175
RC-1	100	150	MC-2	125	200
RC-2	125	175	MC-3	175	250
RC-3	150	200	MC-4	200	275
RC-4	175	225	MC-5	225	275
RC-5	200	250	Asphalt Cement		
SC-0	50	125	50-200		275
SC-1	100	175	200-350		350
SC-2	150	225	Emulsified Asphalt		
SC-3	200	300	RS-1		50
SC-4	225	325	RS-2		120
SC-5	250	350	MS-2		100
SC-6	250	350	SS-1		50
MC-0	50	125	RS-2C		120
					160

(G) Alternate Type or Grade of Bituminous Materials. See Article 06.01.

30.04 METHOD OF MEASUREMENT. Bituminous material will be measured by the U. S. gallon or by the ton, as stipulated in the proposal.

(A) If measured by the gallon, the volume shall be determined at a temperature of 60° F., or corrected to this basis by means of the appropriate Group table as designated in Volume Correction Tables, ASTM D 1250. Bituminous materials, when measured by the gallon, shall be transported in tanks previously certified as to their capacity and each tank shall be accompanied by its proper measuring rod and calibration card. Railroad tank cars shall have available inage and outage tables and dome capacity charts.

(B) When measured by the ton, the weight shall be determined on scales furnished by the supplier or on public scales most accessible to the source. Each vehicle used in transporting bituminous materials, other than railroad tank cars, shall be weighed completely empty and after loading and the difference in weights used as the basis for computing the tonnage. Any scale used shall be capable of weighing the transporting unit in an unbroken operation and shall be satisfactory to the engineer. The scales shall be tested and sealed, at the expense of the supplier, as often as the engineer may consider necessary to insure their accuracy.

In the case of plant mix operations the bituminous material may be weighed, if satisfactory to the engineer, by the plant scales.

If railroad tank cars are to be used in transporting bituminous materials, railroad-car weights will be accepted as the basis for computing the weight of bituminous material, provided that the loaded car is weighed over track scales. The stenciled tare on the car, unless proven to be erroneous, will be used in determining the net weight.

An inspector, appointed and compensated by The Commission, shall be in attendance at all weighing operations to conduct or witness such operations.

Full compensation for weighing bituminous material as specified shall be considered as included in the unit price bid per ton for the bituminous material and no additional compensation will be made therefor.

30.05 BASIS OF PAYMENT. Bituminous material, used in the completed and accepted work, will be paid for at the contract unit bid price, which price and payment shall include all demurrage, storage, handling and other charges, all materials (including the bituminous material), tools, equipment, labor and performance of all work necessary or incidental to the furnishing, delivering, heating, hauling, manipulating and application of the bituminous material, unless otherwise expressly provided for.

The item description used in proposal forms will abbreviate "Penetration Asphalt Cement" to "Asphalt Cement"; e.g., "85-100 Penetration Asphalt Cement" will be listed as "85-100 Asphalt Cement."

* * * *

SPECIFICATION FOR CATIONIC EMULSIFIED ASPHALT — (RS-2C)

DESCRIPTION. Cationic Emulsified Asphalt (nonmixing grade) shall be a homogeneous emulsion. It shall remain homogeneous for not less than three months, unless separation has been caused by contamination or freezing. When tested, as hereinafter specified, the emulsion shall conform to the following requirements:

Test Requirements.

Percent residue, by distillation or evaporation	65 Min.
Oil Distillate, percent	0-5
Viscosity, seconds Saybolt-Furol at 122° F.	50-300
Sieve Test	0.10 Max.
Particle Charge	Positive

Methods of Testing. Tests on the cationic emulsified asphalt shall be made in accordance with ASTM D 244, except as hereinafter described:

Sieve Test—Replace the sodium oleate solution (2 percent) with distilled water. Use distilled water in all operations, including wetting and subsequent washing of the wire cloth.

Particle Charge Test—This test is made by an electroplating process, using a suitable source of direct current electricity* Metal plates, 1" x 3" numbered 1 and 2, are connected respectively to the known positive and negative terminals of the D.C. current supply. The plates are immersed to a depth of 1" in the emulsion sample. When the switch is closed a current of 4 milliamperes or more should flow through the circuit. After one minute, open switch and remove plates. Gently wash plates, if necessary, with distilled water to remove unbroken emulsion, and then examine. The positively charged particles are attracted to the negative plate.

An appreciable layer of deposited asphalt on the negative (No. 2) plate with a relatively clean asphalt-free positive (No. 1) plate signifies a positive particles charge.

* (Potential should be adequate to give milliammeter reading of 4 or more during testing.)

ASPHALT RESIDUE

Test Requirements. The residue obtained from the distillation or evaporation test shall conform to the following:

Penetration of Residue (77° F., 100 gm., 5 Sec.) ... 100-250

Solubility in CC₁₄, percent 98 Min.

Ductility* 40 Min.

* Run at 77° F. for 100-200 penetration asphalt; at 60° F. for 200-250 penetration asphalt.

Methods of Testing. Tests on the residue shall be made in accordance with current ASTM Standard Methods, except as follows:

Ductility—When the ductility test is made the screened residue shall be kneaded and intimately mixed until uniform and homogeneous, prior to testing for ductility.

SPECIFICATION FOR ASPHALT CEMENT

TABLE 30 - M - 20

PENETRATION GRADES	40 - 120		120 - 150		150 - 200		200 - 300	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Penetration grade, as specified	40	50	120	150	150	200	200	300
Flash point, Cleveland open cup, degree Fahrenheit	40	—	—	—	—	—	—	350
Ductility at 77° F., 5 cm. per min., cm.	100	—	100	—	—	—	—	—
Loss on heating, 325° F., 5 hr., percent	—	1.0	—	1.0	—	1.0	—	1.0
Penetration of residue from loss on heating test, at 77° F., 100 g., 5 sec., as compared to penetration before heating, percent	75	75	75	75	75	75	75	75
Solubility in carbon tetrachloride, percent	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5
Ash, percent	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Heptane-Xylene Equivalent	Negative		for all grades					
Test — 35% Xylene								

Notes: 1—Petroleum asphalt shall be prepared by distillation or solvent extraction of asphaltic petroleum.

2—The asphalt cement shall be homogeneous, free from water, and shall not foam when heated to 347° F.

SPECIFICATION FOR RAPID CURING CUT-BACK ASPHALT

TABLE 30 - M 81

Notes: 1—Scope. These specifications cover liquid petroleum products, produced by fluxing an asphaltic base with a suitable light volatile solvent, to be used in the treatment of road surfaces.

2-2-General Requirements: The cut-back asphalt shall be free from water and shall show no separation or curdling prior to use.

SPECIFICATION FOR MEDIUM CURING CUT-BACK ASPHALT

TABLE 30 - M - 82

GRADE	MC - 0		MC - 1		MC - 2		MC - 3		MC - 4		MC - 5	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Flash point (Tag open cup) degrees Fahrenheit 100	100		150		200		250		500		125	
Viscosity, Saybolt-Furol	75	150	75	150	60	90	87	95	85	40	30	600
at 77° F., sec.												
at 122° F., sec.												
at 140° F., sec.												
at 180° F., sec.												
Distillation test:												
Distillate, (% by vol. of tot. dist. to 68° F.)	25		20		10		5		0			
to 437° F.	40	70	25	65	15	55	5	40	30	20		
to 500° F.	75	93	70	90	60	87	55	85	40	30	20	75
to 600° F.												
Residue from dist. to 680° F., % vol. by diff.	50		60		67		73		78			
Tests on residue from distillation:												
Penetration	120		300		120		300		120		300	
Ductility at 77° F. for residues of less than 200 penetration at 77° F., cm.	100		100		100		100		100		100	
Ductility at 60° F. for residues of 200-300 penetration at 77° F., cm.	100		100		100		100		100		100	
Solubility in carbon tetrachloride	99.5		99.5		99.5		99.5		99.5		99.5	
Heptane-Xylene Equivalent Test — 35% Xylene			Negative for all grades									

Notes: 1—Scope: These specifications cover liquid petroleum products, produced by fluxing an asphaltic base with soluble distillates, to be used in the treatment of road surfaces.

2—General Requirements: The cut-back asphalt shall be free from water and shall show no separation or curdling prior to use.

SPECIFICATION FOR SLOW CURING
LIQUID ASPHALTIC ROAD MATERIAL

TABLE 30 - M - 141

GRADE	SC - 0		SC - 1		SC - 2		SC - 3		SC - 4		SC - 5		SC - 6	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Water, Percent by Volume			0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Flash Point, F.	150	150	175	175	200	200	225	225	250	250	275	275		
Viscosity, Saybolt Furol	75	150	75	150	100	200	250	500	125	250	300	600	250	500
at 77° F., sec.														
at 122° F., sec.														
at 140° F., sec.														
at 180° F., sec.														
at 210° F., sec.														
Asphalt residue of 100 pen. % by weight	40	50	60	70	75	75	80	80	90	90				
Ductility of 100 pen. residue														
at 77° F.-5cm./min., cm.	100	100	100	100	100	100	100	100	100	100	100			
Solubility in CCl ₄ , percent (see Note 3)	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5			
Total distillate to 680° F., % by volume	15-40	10-30	5-25	2-15	2-15	0-10	0-5	0-2						
Float test of distillation residue at 122° F., see. Hepane-Xylene Equivalent	15	100	20	100	25	100	50	125	60	150	75	200	150	350
Test — 35% Xylene														
for all grades														

Notes: 1—General Requirements: Each shipment of oil shall be uniform in appearance and consistency and shall show no foaming when heated to 225° F.

The residue of specified penetration shall be smooth and homogeneous in appearance.

2—If material fails to meet requirements for solubility, it will be accepted if its solubility in CS₂ is 99.0% + and the proportion of bitumen soluble in CCl₄ is 99.65% +.

SPECIFICATION FOR EMULSIFIED ASPHALT

TABLE 30 - M - 140

Type	RS - 1		RS - 2		MS - 2		SS - 1	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity, Saybolt-Furo!								
At 77° F., Seconds	20	100	75	400	100	—	20	100
At 122° F., Seconds	—	—	60	—	60	—	—	—
Residue by Distillation, percent	55	—	3	—	3	—	57	—
Settlement, 5 days	—	—	—	—	—	—	45	—
(a) Demulsibility 50 ml. of 0.1N, CaCl ₂ percent	—	—	—	—	—	—	—	—
(a) Demulsibility 35 ml. of 0.02N, CaCl ₂ percent	30	90	60	—	0.10	—	0.10	—
Sieve Test, percent	—	0.10	—	—	—	—	—	0.05
Miscibility with Water	—	—	—	—	—	—	(c)	—
Coating Test	—	—	—	—	—	—	(d)	—
Modified Miscibility with Water	—	—	—	—	—	—	—	—
Cement Mixing Test, percent	—	—	—	—	—	—	—	—
RESIDUE: The residue obtained from distillation	—	—	—	—	—	—	—	—
shall conform to the following requirements:	—	—	—	—	—	—	—	—
Penetration, 77° F., 100 g., 5 seconds	100	200	100	200	100	200	100	200
Solubility in Carbon Tetrachloride, percent	97.5	—	97.5	—	97.5	—	97.5	—
Ductility, 77° F., cms.	40	—	40	—	40	—	40	—

Notes: 1. Emulsified asphalt shall be homogeneous. It shall show no separation of asphalt after thorough mixing within 30 days after delivery, provided separation has not been caused by freezing.

2. At least one sample of not less than one gallon shall be taken from each lot or shipment of the emulsified asphalt after arrival at its destination. The samples shall be stored in clean, airtight glass or black iron containers at a temperature of not less than 40° F. until tested.

(a) The demulsibility test shall be made within 30 days from date of shipment.

(b) If the sample of emulsified asphalt being tested fails to conform to the requirements for modified miscibility, the sample shall be tested for 5-day settlement and for miscibility. If the numerical difference between the average percentages of the asphalt residue in the 5-day settlement test is less than 3, and if the standard miscibility test shows no appreciable coagulation or visible separation in 2 hours, then the emulsified asphalt shall be considered as conforming to these specifications and shall be accepted.

(c) The emulsified asphalt shall show no appreciable coagulation nor visible separation in two hours.

(d) The emulsified asphalt shall show no appreciable separation of the asphaltic base from the water of the emulsion and shall coat the stone thoroughly.

**SPECIFICATION FOR RUBBERIZED
RAPID-CURING CUTBACK ASPHALT**

TABLE 30 - LBFT-T

SPECIFICATION DESIGNATION	TESTS AASHO METHOD		
	RC - 3D	RC - 4D	RC - 5D
Flash Point, degrees Fahrenheit	80+	80+	80+
Furol Viscosity at 140° F., sec.	250-500	125-250	300-600
at 180° F., sec.			(1)
Distillation: Dist. (% of Tot. Dist. to 370° F.)	25+ 55+ 83+ 100	8+ 40+ 80+ 100	— 25+ 70+ 100
to 177° F. to 228° F. to 302° F. to 370° F.			
Residue from distillation to 370° F. (Percentage volume by difference)	67+	73+	78+
Tests on residue from distillation:			
Penetration at 77° F., 100 gms, 5 sec.	80-120	80-120	80-120
Ductility at 77° F., 5 cm/min.	100+ 150+	100+ 150+	100+ 150+
Ductility at 39.2° F., 5 cm/min.			
Heptane-Xylene Equivalent	Neg.	Neg.	Neg.
Heptane-Xylene Test — 35% Xylene	0.9-1.2	0.9-1.2	0.9-1.2
Separation Ratio Test			(3)

Notes: 1—ASTM D 1189 Method of test for vacuum distillation of liquid and semi-solid asphaltic materials to obtain a residue of specified penetration (tentative) except as herein modified:

a—Distillate receiver is immersed in ice and salt to condense all vapors.

b—End point is 370° F. liquid temperature to protect rubber.

2—AASHO T 51 except that the rate of pull is 1 cm./min. in lieu of the specified 5 cm./min. in the test.

3—Separation Ratio Test: This test, which measures the stability of properties of rubberized asphalt cutbacks, is performed as follows: A quart sample of the rubberized cutback is placed in quart can, covered tightly and left to stand 24 hours in an oven at 200° F. Then the top portion and the bottom portion are withdrawn and the viscosities of both are measured. The ration of viscosity of the top to the bottom portion is the "Separation Ratio."

4—General Requirements: The rubberized rapid-curing asphalt cutback shall consist of an intimate blend of vacuum-refined asphalt cement and vulcanized rubber fluxed with a suitable solvent to meet the requirements of these specifications. The material shall be free from water.

SECTION 32

BITUMINOUS PRIME OR TACK COAT

32.01 DESCRIPTION. "Prime Coat" and "Tack Coat" shall consist of the application of specified bituminous material in accordance with these requirements and in conformity with the specifications and plans.

Prime Coat shall be the application of bituminous material to a previously prepared aggregate or soil surface roadway, preparatory to placing surfacing materials.

Tack Coat shall be the application of bituminous material to a previously constructed surface of any type, in preparation of placing bituminous surfacing materials.

32.02 MATERIAL. Bituminous material shall be the type and grade stipulated in the proposal or shown on the plans and shall meet the requirements of Section 30.

32.03 EQUIPMENT. Shall conform to Article 33.03 to the extent required for satisfactory accomplishment of The Work.

32.04 CONSTRUCTION METHODS. Construction shall be performed in accordance with Article 33.04 except as herein modified or supplemented.

(A) Modifications. Prime Coat may be applied only during daylight, when the atmospheric temperature is not less than 50°F., and rising.

Tack Coat may be applied only during daylight, when the atmospheric temperature is not less than 40°F., and rising.

Neither Prime nor Tack Coat may be applied when the engineer determines that weather or roadway surface conditions are unfavorable to achievement of satisfactory results.

Amounts of bitumen to be applied and the rates of application shall be as directed by the engineer, in accordance with on-the-job determinations of the particular work requirements.

(B) Supplemental. The contractor may, at his option and at his own expense, when permitted by the engineer, apply suitable material for "Blotting" those areas where the bitumen has not "set-up" or dried sufficiently to prevent damage by traffic. In the case of a prime coat to be applied on an aggregate surface, the contractor may be permitted, as directed, to windrow a small amount of the aggregate surfacing to one side of the area to be primed. This windrowed material may subsequently be spread, for "blotting" purposes, over the freshly applied bitumen by blading, brooming or other approved methods. Being to the benefit of the contractor to facilitate his operations in this manner and prevent damage to the freshly primed sur-

face by this method, such "blotting" operations, shall be at his sole expense.

If determined that the prime coat can be improved by compaction, The Work, when directed, shall be accomplished with approved type rollers according to prescribed methods. Surplus aggregate, resulting from any method of "blotting" freshly spread bitumen, shall be completely removed from the roadway surface in conformity with the hereinbefore prescribed methods, prior to the placing of any subsequent bituminous surfacing.

(C) The contractor shall maintain the prime or tack coat surface intact until it has been covered with subsequent surfacing. Any breaks, holes, failures or deterioration of any kind or disintegration of the underlying course or courses of surfacing, suffered from any cause, shall be satisfactorily repaired. Costs of any such repairing, including any materials as necessitated, will not be paid for directly, but shall be considered necessary and incidental to the completed work and included in the bid items of the contract.

32.05 PROTECTION OF TRAFFIC AND HIGHWAY STRUCTURES. Shall be performed in accordance with Article 33.05.

32.06 METHOD OF MEASUREMENT. Bituminous material will be measured in accordance with Article 30.04.

Rolling, watering and other contract items will be measured in accordance with Sections 14 and 15 and other pertinent sections.

When the proposal form specifies that bituminous material shall be furnished to the Project, but not applied to the roadway, then measurement shall be made in the vehicle, delivered on the site, in accordance with Article 30.04.

32.07 BASIS OF PAYMENT. Bituminous material will be paid for at the contract unit bid price in accordance with Article 30.05.

Rolling, watering and other items will be paid for at the contract unit bid prices in accordance with Sections 14 and 15 and other pertinent sections.

When the proposal form specifies that bituminous material shall be furnished to the project, but not applied to the roadway, then payment shall be made for the measured quantity, delivered on the site, in accordance with Article 30.05.

SECTION 33

BITUMINOUS SURFACE TREATMENT

33.01 DESCRIPTION. "Bituminous Surface Treatment" shall consist of one or more applications of bituminous material on a properly prepared roadway surface with each application, unless specified otherwise, being covered with aggregate surfacing material in conformity with these requirements and the specifications and plans.

33.02 MATERIAL. (A) Bituminous Material shall be the type and grade stipulated in the proposal or shown on the plans and shall meet the requirements of Section 30.

(B) Aggregate for covering the bituminous material shall be the type and grade stipulated in the proposal or shown on the plans.

(C) Quantities of bitumen and aggregate will be as specified in the plans or as directed by the engineer.

33.03 EQUIPMENT. The contractor shall maintain on the Project, throughout the course of the work, the following listed, previously approved, equipment:

(A) One fully operable bituminous material pressure distributor of at least one-thousand (1,000) gallon capacity meeting the following requirements: The tank shall be insulated and equipped with internal steam coils or equivalent heating facilities. The distributor shall be fully equipped with a spray bar of the full circulating type at least nine feet in length, so constructed as to permit adjustment for length in increments of one foot for any lengths up to sixteen feet, to allow vertical adjustment of all nozzles to the desired height above the road surface and conforming to the roadway crown and to permit lateral shifting of the entire spray bar during operation. The spray bars and nozzles shall be constructed so as to prevent clogging of the nozzles during intermittent operation and to provide positive and immediate cutoff when distribution of the bitumen ceases, thus preventing dripping of the bitumen from the bar. The nozzles attached to the bar shall be either of the conical or flat-slotted type. The valves which control the flow from nozzles shall be of positive acting design so as to provide a uniform unbroken spread of bitumen on the surface.

The distributor shall be equipped with devices and charts to provide for accurate rapid determination and control of the amount of bitumen being applied per square yard of surface and with a tachometer of the fifth-wheel type indicating speeds in feet per minute. The pressure pump shall be powered independently from the propelling motor of the vehicle. The distributor shall be equipped with a pressure pump, pressure gauge, thermometer well, thermometer and an accurately calibrated fluid content gauge. It shall be equipped with pneumatic

tires of sufficient number to meet the legal road requirements of the State and shall be adequately powered to perform the necessary work without assistance from other units. In addition, the distributor spray bar shall be so arranged that its height above the roadway, as set, shall remain constant throughout the application of bituminous material to the surface.

(B) Heating Equipment. For heating bituminous material to the required application temperature.

(C) Rollers. Rolling equipment shall meet the requirements of Article 14.02(B)(1) and 14.02(D).

(D) Aggregate Spreader. One self-propelled or truck mounted aggregate spreader of the force feed type with rate of application control independent of spreader motive power.

(E) Cleaning Equipment. For cleaning roadway surface, such as efficient power brooms, blowers and suitable hand brooms.

(F) Water Facilities. For wetting cover aggregate if and as required.

(G) Watering Equipment. Shall conform to Article 15.02.

(H) Scales. Shall meet the requirements of Article 20.03 (E).

33.04 CONSTRUCTION METHODS. **(A) Existing Surface Preparation.** Unless surface preparation is included in surfacing items of the contract, the required work shall be performed in accordance with the pertinent provisions of Article 16.12, except as may be herein modified or supplemented.

Particular attention is directed to the condition that surface stability and excellence of the riding quality of the completed bituminous surface treatment is completely dependent on the careful preparation and smoothness obtained of the aggregate surface to which the treatment is applied. In any case, the entire course of aggregate composing the surface to which the bituminous surface treatment is to be applied shall not be laid down and prepared until such time as weather and other pertinent conditions will permit the application of bitumen.

It shall be the intent of this specification that the contractor shall not place any cover aggregate upon the roadway until such a time that he can complete the paving operations without interruption. If the paving operation cannot be completed, the cover aggregate may be stockpiled at his option.

In the event the contractor elects to produce the cover aggregate at such a time that the paving cannot be completed and elects to stockpile the material for later use, the cost of stockpiling, loss of material through stockpiling, loading, and incidentals involved in placing the cover aggregate from the stockpile shall be done at the sole expense of the contractor.

(B) Sweeping. Immediately in advance of the first application of bituminous material, the roadway surface shall be swept clean of all dust, dirt or foreign matter, by means of a power broom, blower or hand brooming as required for satisfactory cleaning of the surface. When directed, a light uniform application of water with compaction, if required, shall be applied to the roadway surface with the specified type equipment, just prior to application of the bitumen. The top two inches of the course shall not contain more than three percent of moisture by weight of aggregate. If determined necessary by the engineer, as a measure of surface consolidation, a prime coat of bituminous material shall be applied, at the rate directed, prior to the initial application of bituminous surface treatment.

(C) Application of Bitumen. Immediately following the cleaning and wetting of the roadway surface, the first application of bitumen shall be uniformly applied at the temperature and at the rate per square yard, as directed, by means of a pressure distributor of the type described hereinbefore. Bitumen shall not be applied until the atmospheric temperature is at least 65°F. and rising. Extreme care shall be taken in application of the bitumen to secure uniform surface cover and true lines. In case of either type of bituminous material, weather conditions shall be such that the bitumen will not become chilled before the cover material can be spread and rolled. Work shall not be started without consent of the engineer and shall be promptly terminated in the event of rain, high wind velocity or the occurrence of unfavorable road or weather conditions.

(D) Application of Cover Aggregate. When directed by the engineer, the first application of bitumen may be allowed to remain uncovered for a period of time up to sixty minutes. Spreading of a minimum amount of cover aggregate shall be made on the freshly spread bitumen, when the engineer determines that the maximum depth of downward penetration has been attained and that the consistency of bitumen has become such that the best "keying" results will be obtained. In the case of heavy viscosity types of bituminous materials, the contractor shall not proceed with the application of bitumen until a supply of aggregate sufficient to cover the entire application is immediately available for covering the bitumen in less than five minutes. The bitumen application shall be covered with the specified cover aggregate, at the directed rate per square yard, spread uniformly over the bitumen with a self-propelled or truck mounted mechanical spreader of the type hereinbefore specified. Aggregate spreaders that fail to make a uniform and satisfactory distribution of material must be promptly removed from further use. Special care must be exercised in the spreading of cover aggregate in order that uniformity of cover and longitudinal lines will be secured. Operation of the spreader motive equipment shall, at all times, be assigned to the same experienced operator.

When directed by the engineer, the cover aggregate for any course may be wetted by watering, prior to spreading it upon the bituminous material.

Brooming by mechanical or hand methods, if directed by the engineer, shall be employed to insure uniform distribution of the cover aggregate. When brooming is resorted to, particular caution must be exercised to avoid displacement or loosening of particles of cover aggregate from the bitumen.

Bituminous material applications shall not be made to such a distance that uncovered bitumen in "meet line" areas will become chilled to such extent during the time interval, that it will not successfully "key" the maximum amount of cover aggregate. Bitumen must be applied in such manner and with such care that transverse and longitudinal joints or "meets" of successive applications will not result in ridges or depressions and will be smooth, consistent with the adjacent surface of the completed treatment.

Longitudinal laps (meet lines) may be from six to ten inches in width, but there shall be no overlap at the end junction of applications. In order to prevent lapping at transverse junctions, the distributor shall be promptly shut off, and, if necessary to prevent dripping, a drip pan shall be inserted under the nozzles when the application begins to thin. Before continuing application of the bitumen, building paper or metal sheets shall be spread over the treated surface for sufficient distance back from the joint on the cover aggregate so that the sprayers are operating at full force, and the distributor has attained the predetermined speed upon reaching the surface to which application is to be made. The bitumen application shall be stopped or shut off on paper or metal sheets. Any paper used for covering joints shall be removed and destroyed.

All transverse joints shall be covered with aggregate and shall be broomed back before the next longitudinal application of bitumen is made. Trucks hauling covering material to the spreader units, or traffic, shall not be permitted at any time, or under any circumstances, to cross over or drive on any uncovered bituminous material including "meet" lines. When operating over freshly spread cover aggregate, the speed of vehicular traffic shall be so regulated that loosening and displacement of cover aggregate will not occur. Trucks failing to observe these requirements shall be promptly dismissed from The Work. When it is necessary to cover "meet" lines to permit trucks or traffic to cross over, such cover aggregate shall be neatly broomed back exposing the full width of the "meet line" before the abutting application of bitumen is made.

There shall only be permitted a minimum number of "meet" lines, compatible with the width of the roadway surface. Permission may be granted by the engineer to make full road surface width application of bitumen and cover aggregate, to be performed in a single continuous operation so coordinated that the movement of public traffic will not suffer greater in-

breaks that may occur shall be satisfactorily repaired by methods hereinbefore specified. Any areas showing excess bitumen shall be covered with aggregate and rolled. Any irregularities influencing the stability and riding quality of the surface shall be corrected in a satisfactory manner. Cost of any such repairing or corrections shall not be paid for directly but shall be included in the other bid items in the contract.

33.05 PROTECTION OF TRAFFIC AND HIGHWAY STRUCTURES. (A) **Traffic Protection.** This shall be performed, unless otherwise stipulated, in accordance with Schedule 2, Article 16.31.

(B) **Structure Protection.** The contractor shall provide whatever protective covering may be necessary to protect exposed portions of bridges, culverts, curbs, gutters, guard fences, road signs and other roadside structures from becoming splashed or sprayed with bitumen and he shall remove from such structures, any bitumen, dirt or other undesirable matter that may come upon them by reason of his operations. Compensation for this protection shall be included in the unit price bid for the application of bituminous material.

(C) The contractor shall recondition, at his expense, any damage done to the Highway or structures due to the operation of his equipment or caused by traffic being forced away from the usual line of travel.

33.06 METHOD OF MEASUREMENT. (A) Bituminous material used in the completed and accepted work will be measured by the U. S. Gallon, or by the ton, as stipulated in the proposal and in accordance with Article 30.04.

(B) Cover aggregate used in the completed and accepted work will be measured by the ton on scales furnished by the contractor, or by the cubic yard measured in the vehicle at point of delivery on the roadway, as stipulated in the proposal and in accordance with Article 20.07.

(C) Rolling will be measured as provided for in Article 14.04.

(D) Other items specified in the contract will be measured as stipulated in the proposal.

(E) Traffic Protection will not be measured unless specified otherwise.

33.07 BASIS OF PAYMENT. (A) Application of any bituminous material, cover aggregate, rolling, watering and any other items specified in the contract, will be paid for at the contract unit price bid for the unit specified in the proposal, which prices and payment shall each be full compensation for furnishing all material, unless otherwise indicated in the proposal; for delivering, preparing, handling and placing all materials and for all other charges; for maintenance of the completed surface until acceptance and for all other operations necessary to complete The Work.

convenience than that resulting from strip or half roadway width methods.

(E) Rolling. Rolling of cover aggregate shall commence immediately upon spreading and shall be prosecuted with such diligence that all freshly spread material shall be promptly rolled without delays of any nature. Rolling shall be accomplished with pneumatic tired rollers so equipped as to exert a ground contact pressure of not less than 50 psi nor more than 95 psi. Rolling shall proceed in a longitudinal direction beginning at the outer edges of the treatment and working toward the center, each trip overlapping the prior trip by about half the width of the roller. The first rolling of the aggregate must be completed within one-half hour after it has been spread. All rollers shall be self-propelled and two rollers must be used for each aggregate spreader used. The rolling shall be continued only until a smooth thoroughly compacted surface has been obtained. The speed and reversal of direction of movement of all rollers shall be so regulated as to avoid displacement or loosening of cover material.

(F) Curing Time After First Application. After rolling is completed and the surface is smooth and free of ruts and ridges, the surface may be opened to traffic subject to traffic control requirements as hereinafter specified.

The surface shall be allowed to cure for a minimum period of five days and longer, if necessary, as determined by the engineer, for the surface to become satisfactorily cured for placement of the succeeding course. The second application shall not be applied before May 15 nor later than September 15 without written approval by the engineer. Any breaks or holes that develop in the treated surface shall be substantially repaired immediately with bituminous treatment methods or a premixed bituminous aggregate. Any areas showing excessive bitumen shall be covered with aggregate and rolled. Cost of any such repairing required shall not be paid for directly but shall be included in the other bid items in the contract.

(G) Cleaning. After the first application of bitumen and cover aggregate has satisfactorily cured and set, as directed by the engineer, and any repairs required have been properly made, all excess cover aggregate, dirt, dust and foreign materials shall be removed from the surface by sweeping with power brooms, hand brooms, blowers or water washing to produce a positively clean surface. Construction of the succeeding course may then proceed on the clean surface using a repetition of the construction methods specified for the preceding course.

(H) Completion. Upon completion of this course, if it is the final course, the surface shall be opened to traffic for a period of three (3) days, with the specified period of traffic control in effect. During this period, the surface shall be maintained by brooming and rolling, as directed. Any holes or

(B) On projects in which the construction of the base and bituminous surface treatment is included in one contract, "Existing Surface Preparation" will not be paid for as a separate item, but shall be considered as incidental to the base construction.

(C) On projects in which bituminous surface treatment is contained in a separate contract, "Existing Surface Preparation" shall be performed in accordance with Subsection 16.10. In this case, if and unless specified in the proposal, the work required of existing surface preparation will not be paid for directly, but shall be considered incidental to the payment for and performance of the other items in the contract.

Watering of cover aggregate shall not be paid for directly but shall be included in the price bid for other items.

For Payment of Bituminous Material — See Section 30.

For Payment of Cover Aggregate — See Section 27.

For Payment of Rolling — See Section 14.

For Payment of Traffic Protection — See Subsection 16.30,
if a pay item.

Unless otherwise provided, traffic protection will not be paid for directly, but shall be considered incidental and necessary to the performance of, and included in the payment for the other items of the contract and shall include all labor, equipment, tools, lights, signs and all incidentals necessary to complete The Work.

SECTION 34

ROAD MIX

BITUMINOUS SURFACING

34.01 DESCRIPTION. "Road Mix Bituminous Surfacing" shall consist of aggregate and bituminous material, constructed on the roadway by mechanically mixing and processing these materials and spreading and compacting the resulting completed mixture in accordance with these requirements and the specifications and plans.

34.02 MATERIAL. (A) Bituminous material shall be the type and grade stipulated in the proposal or shown on the plans and shall meet the requirements of Section 30.

(B) Aggregate to be bituminized shall be either all new aggregate, of the type and grading stipulated, or a blend of new aggregate and material obtained from the existing roadway surface or entirely material obtained from the existing surface, as may be required by the proposal or plans.

34.03 ORGANIZATION. On projects five (5) miles or more in length, the organization shall be capable of completing at least one-half ($\frac{1}{2}$) mile of continuous road mixed surface each day. On projects less than five (5) miles in length, the organization shall be sufficient to accomplish completion of the road mix construction in ten working days or less. When the Project is used by traffic, the rates of progress on the various phases shall be such that only a minimum length of work will be under construction at one time.

Sufficient mixing units shall be maintained on the Project to insure compliance with the required rate of construction progress.

34.04 EQUIPMENT. **(A) Bituminous Distributor.** The contractor will be required, regardless of project length or type of mixing equipment being used, to maintain on the Project, a bituminous distributor meeting the requirements of Article 33.03.

(B) Motor Graders. Shall meet the requirements of Article 20.03.

(C) Road Plants and Machines. All traveling road mixing plants and machines shall meet with the approval of the engineer. Such plants or machines must be equipped with positive measuring devices, to be set by the engineer and not varied except by his order, for the accurate volume or weight measuring and proportioning of the bitumen and aggregate. Aggregate pickup devices shall be capable of taking up all loose material, leaving the base surface clear and undamaged. Mixing machines which do not pick up the aggregate also may be used, if approved. Auxiliary mixing machines which mix the material on the roadway, but are not equipped with a bitumen proportioning device, also may be used. If the windrow is too large for the machine to handle properly, it may be divided into two or more windrows of workable and equal size.

Use of any traveling plant or mixing machine anticipates the auxiliary use of blade graders to properly aerate the materials, complete the mixing operation and perform "laydown" of the mixture. Irrespective of the type of road mixing plant or machine used, the contractor shall maintain on the Project not less than two motor graders of the type specified.

Any motive equipment, regardless of type or kind, shall be adequately powered to prevent damage, to the roadway surface upon which it is working, from slippage or spinning of the traction contact areas.

(D) Stationary Plants. If approved, the mixing of new aggregate and bituminous material in a stationary plant may be permitted. In this case mixing and aeration of the material, if not completed in the plant, shall be completed on the roadway as required under these specifications. The contractor may be permitted to accomplish mixing, spreading and compacting of the materials as specified in Section 35. In the event

of use of stationary plant methods, no compensation other than price adjustment for change of type or grade of bituminous material will be allowed.

(E) Rollers. Rollers shall be the type specified in Article 14.02(D).

34.05 CONSTRUCTION METHODS. **(A) Limitations and Conditions.** **(1) Weather, Season and Time.** The operations of bitumen application, machine or blade mixing, aeration, spreading or compacting shall not be done prior to May 15th, nor shall it be continued later than September 15th, except upon written approval by the engineer. Such operations shall not be done when the temperature, weather and road conditions are such that the specified results cannot be obtained. No work shall be prosecuted except in daylight.

(2) Scope of Operations. The contractor shall not open up more than two miles at one operation and at no time shall there be more than three miles under process of actual bituminous construction.

(3) Stockpiling. The contractor shall not place any aggregate, either new or that obtained from the existing surface, upon the roadway until such time that he can complete the mixing operation without interruption. If this operation cannot be completed the material may be stockpiled, at his option. If the contractor elects to produce the new aggregate at such time that the mixing operation cannot be completed, the aggregate may be stockpiled for later use and the costs and all incidentals involved in the stockpile operation shall be at the complete expense of the contractor.

(4) Moisture Content. Should the moisture content of the aggregate exceed three percent by weight, it shall be dried before applying the bitumen. If approved, the contractor may use a previously approved commercial anti-stripping additive in the bitumen, at his own expense, to assist mixing, when the mixture is not in excess of five percent.

In event of rain during the application of bitumen, or the mixing operation, the material shall be windrowed promptly. If rain occurs and the treated or untreated material is windrowed on the roadway, the contractor shall immediately drain any water puddles. The treated material and the base shall be allowed to dry before the resumption of any work, except such mixing as will facilitate drying. In no case shall the bituminized material be "laid" while either the material or the roadbed is damp or wet. The engineer shall be sole judge as to when the roadbed has dried sufficiently for work to be resumed. However, in no case shall the moisture content in the upper six inches of the base be more than three and one-half ($3\frac{1}{2}$) percent when the mixture is "laid."

(B) Protection of Traffic and Highway Structures. "Protection of Traffic" shall be performed in accordance with Sched-

ule 1, Article 16.31. "Protection of Highway Structures" shall conform to Article 33.05.

Work will be considered in progress whenever the contractor's equipment is on the roadway, regardless of whether or not it is in motion, or when material has not been windrowed in a safe manner. At night, or at other times when active work is not in progress, all material shall be left in a uniform windrow, placed as directed, in order to leave the roadway in the "safest possible condition for use of the Public." At night the treated or untreated gravel windrow shall be lighted with lanterns or suitable flares which shall be spaced at such intervals as to clearly indicate the position of the windrow and at such other intervals as may be directed. No other equipment, except traveling road mixing plants, may be left on the roadway when active work operations are not in progress and such plants shall be clearly marked with the use of danger signs, signals and flares.

(C) Prime or Tack Coat. Application of prime coat or tack coat, as the case may be, when designated on the plans and proposal, or directed, shall be accomplished in accordance with Section 32.

(D) Aggregate. **(1)** Where aggregate is to be obtained, in whole or in part, from the existing roadway the surface shall be scarified to a depth which will produce the quantity of loose material required for the compacted thickness of the bituminous surfacing shown on the plans. Extreme care shall be exercised to avoid loosening of the base surface or scarifying below the depth necessary to produce the required amount of material. All clods shall be broken and the loose material bladed into a windrow. The base surface shall then be shaped and compacted to conform to the typical section. When it is specified that new material is to be blended with material obtained from the existing roadway, the amount of new material to be added shall be designated on the plans or by the engineer. Blending of the old and new material shall be complete, in all respects, before the application of any bitumen.

(2) When new aggregate is to be used the existing roadway surface shall be shaped and compacted to the design sections shown on the plans and the prime coat applied, when directed, prior to placing the new aggregate. The new aggregate for the bituminous surface course shall be placed in a uniform windrow on one side of the roadway. After the material, either new material or material from the existing roadway, is windrowed at one side of the roadway the windrow shall be equalized in size throughout its entire length by means of graders or mechanical equalizing devices. If necessary, in order to secure uniformity of the windrow, material shall be hauled from sections where there is an excess to those deficient sections.

(E) Bitumen Application. Bituminous material shall be applied at the rates, temperature, and in the manner directed.

All aggregate shall have received uniform amounts of bitumen when the application process is completed. When applied with a distributor, or mixing machines equipped with applicators, the windrowed aggregate shall be spread by laying in successive layers not less than eight (8) feet wide with each preceding layer being applied, full width, with a uniform amount of bitumen. Not less than three layers of aggregate and application of bitumen shall be made.

(F) Processing. After the last application of bitumen and partial mixing the entire mass of surfacing material shall be moved by blade graders into a windrow. The windrow shall then be moved from side to side of the roadway with a revolving motion until all particles of aggregate are coated with bitumen and the whole mass has a uniform color and bitumen content and has been satisfactorily aerated for spreading and compacting the material. At least eight moves of the material across the roadway will be required, under the most favorable conditions of air temperature, material, grading, efficiency of equipment and skillful workmanship. A move shall be understood to consist of the movement of the entire mass from one edge of the proposed roadway section to the other. Under conditions less favorable for effective mixing, as many more moves will be required as is necessary to produce the desired uniformity of mixture. The moving or mixing shall be carried on in such a manner that there will be neither segregation of material nor loss of mineral filler from the mixture.

No portion of mixed material shall be spread, or allowed to remain on the roadway, until the entire mass of material is thoroughly mixed. It then shall be spread and placed in one operation unless, in the judgment of the engineer, it may be expedient to permit the dropping of a small portion of the mixture to serve as a mixing floor.

Any equipment, other than that specified, may be used, with approval of the engineer, if it will produce a completed mixture equal to that which would be produced by the means specified. The engineer reserves the right to order the use of any equipment discontinued which, in his opinion, may damage, to any extent, a section or portion of the roadway or which may fail to produce a satisfactory mixture and completed results.

After the mixing operation is completed the mixture shall be examined to determine whether the proper proportion of bitumen has been used. If the proportion of bitumen is excessive, additional uncoated material shall be hauled onto the moist section, at the option of the engineer, and shall be thoroughly mixed with the original mass by blading. If more bitumen is required a portion of the mixed material shall be spread upon one side of the roadway, the required additional bitumen distributed thereon, and the mixing resumed until uniformity of mixture is secured.

Any oversize aggregate which may enter the mixture, regardless of its origin, shall be forked from the roadway, at the

contractor's expense, during the progress of the mixing. Over-size material, or any rock which will not pass the maximum sieve of the specified grading, shall be considered to be foreign material.

Any costs necessitated through the required addition of bituminous material or untreated surfacing material to correct the uniformity of the mix, or any additional material or work required due to the entrance of moisture or for any other reason prior to the completion of the final rolling of the surface, or for widening of the bituminous surfacing course over intermittent sections for turnouts, traffic lanes, etc., not shown on the plans, shall be considered incidental to the unit price of bid items and no additional compensation for such work will be allowed.

(G) Spreading and Compacting. After a satisfactory mixture, as determined by the engineer, has been obtained, it shall be spread, by a pneumatic-tired motor grader of the prescribed type, to the specified thickness. Rolling shall be carried on, throughout the lay-down operation, with the pneumatic-tired roller commencing with initial blade layout of the bituminous mixture and continuing until the mat is uniformly and thoroughly compacted and all roller marks are eliminated. Rolling shall proceed in a longitudinal direction, beginning at the outer edges and working toward the center or beginning on the low side, on superelevated sections, and working upward. Each trip shall overlap the prior trip by about one-half the width of the rear roll. The pneumatic-tired roller shall be self-propelled and shall exert a minimum working pressure on the mat not less than 85 psi nor more than 110 psi. Final rolling shall be done with the metal-wheeled roller. Roller operating speeds may be between 3 and 5 miles per hour but shall not be of such speed as to cause displacement of material. Any displacement shall be corrected immediately. The use of kerosene or diesel fuel to prevent pick-up on the finishing roller will not be allowed.

Any defects, such as ravelling, low centers, lack of uniformity or other imperfections caused by faulty workmanship shall be corrected to the satisfaction of the engineer and new work shall not be opened up until such defects have been remedied.

However, after the bitumen has been mixed with the aggregate and has been spread and finally compacted in compliance with the specifications, then any additional materials and work, where tear-up and reprocessing are required, will be paid for on a Force Account basis. (See Article C9.06).

This provision shall not cover failures which result from the effects of rain during the spreading or rolling operation or failures which may be patched or repaired by hand methods, but shall apply to those sections of the surface which necessitates tearing up with motorized equipment, adding bituminous material or aggregate, remixing, relaying and compacting.

The finished surface shall be free of ruts, defects and depressions exceeding one-fourth inch, as measured with a ten foot straightedge, paralleling the center of the roadway and shall have an entirely smooth riding quality. Any variations shall be corrected by scarifying and relaying the mixture at the contractor's expense.

(H) Seal Coat. Seal coat, when specified, shall be accomplished according to Section 36.

34.06 METHOD OF MEASUREMENT. **(A)** Bituminous material will be measured in accordance with Article 30.04.

(B) Any new or additional aggregate required for the bituminous surfacing course and the shoulders will be measured in accordance with Article 20.07.

(C) Processing of all bituminous surfacing materials in the completed and accepted work will be measured by the mile along the centerline of the roadway, or by the square yard, as stipulated in the proposal.

(D) Rolling and other contract items will be measured in accordance with the requirements of the respective specifications.

34.07 BASIS OF PAYMENT. **(A)** Bituminous material will be paid for at the contract unit bid price in accordance with Article 30.05.

(B) Any new or additional surfacing aggregate required to construct the bituminous surface course or the shoulders will be paid for at the contract unit bid price in accordance with the respective requirements of Article 20.08.

(C) Aggregate obtained from the roadway will not be paid for directly but shall be considered incidental and necessary to the performance of and payment for the other items of the contract, and shall include all operations necessary to complete The Work.

(D) Processing of the bituminous surfacing materials will be paid for at the contract unit bid price per mile or per square yard, which price and payment shall constitute full compensation for The Work.

(E) Rolling and other items will be paid for at the contract unit bid prices in accordance with the requirements of the respective specifications.

SECTION 35

PLANT MIX

BITUMINOUS SURFACING

35.01 DESCRIPTION. "Plant Mix Bituminous Surfacing" shall consist of aggregate surfacing and bituminous material mixed at a central plant in accordance with these requirements and placed in one or more courses on a prepared or existing roadway surface in accordance with the specifications and plans.

The compacted thickness of each course shown on the plans shall be determined according to the formula in Article 35.10(G).

35.02 TYPES. The types of "Plant Mix Bituminous Surfacing" shall be designated as Type 1 (no-bin separation); Type 2 (2-bin separation) or Type 3 (3 or more bin separation).

35.03 MATERIALS. (A) Aggregate. The aggregate for Type 1 and Type 2 Plant Mix Surfacing shall conform to all the requirements for "Type 'A' Crushed Top Surfacing," Grade 2, unless specified otherwise in the proposal. The composite grading of the specified aggregate produced during any one 8-hour run shall be held to such uniformity that percentages passing the Nos. 4, 10 and 200 sieves for any one sample shall not vary from the average of all samples for the "run" by more than the following tolerances:

Material Passing	Percent
No. 4 Sieve	5
No. 10 Sieve	5
No. 200 Sieve	2

The engineer may, when necessary to obtain a desired and uniform mixture, fix the maximum and minimum percent of aggregate passing the No. 4 sieve within the specified limits and the contractor will not be allowed any compensation for costs incurred in the rejection of fines or adjustments required in conforming to such established limits.

Not less than 50 percent, by weight of the coarse aggregate particles shall have at least one fractured face.

(B) Mineral Filler. Mineral filler shall conform to Sub-section 26.01.

(C) Bituminous Material. The bituminous material shall be the type and grade stipulated in the proposal and shall conform to Section 30. The percentage of bitumen, by weight, to be added to the aggregate shall be, generally, between 3½ and 7 percent of the weight of the dry aggregate. The exact percentage of bitumen in the mix shall be fixed by the engineer, based upon preliminary laboratory tests, sieve analysis and grading and character of the aggregate furnished within the specification limits and the contractor will not be allowed any claim for payment for the rejection of any batch or load of resultant mixture which contains an excess or deficient amount of bitumen varying more than three-tenths (0.3) of one (1.0) percent from the exact percentage as fixed by the engineer.

35.04 REQUIREMENTS FOR ALL MIXING PLANTS. **(A)** Mixing Plants shall be either the weight batching type or the continuous flow mixing type. Both types of plants shall be equipped with satisfactory conveyors, power units, aggregate handling equipment, aggregate screens and bins and shall be so coordinated and operated as to produce a mixture consistent within the job mix tolerance specified.

Batch type plants shall have a minimum batch production capacity of 2,000 pounds and continuous flow plants shall have a minimum production capacity of 60 tons an hour. Suitable to certain job conditions, these capacity requirements may be modified if so stipulated in the proposal. Mixing plants that will not continuously produce a mixture meeting requirement as specified, will be condemned and shall be removed from the job.

(B) Storage and Heating Equipment. Tanks or kettles for storage of bitumen shall have a total capacity sufficient for not less than ten (10) hours run of the mixing plant and shall be capable of heating the bitumen, under effective and positive control at all times, to temperature requirements of Section 30. The heating system shall provide uniform heating of the entire contents of tanks. Heating shall be accomplished by steam coils, electricity or other approved means so that no flame shall come in contact with the heating tanks. The circulating system for bitumen shall be of adequate size to insure proper and continuous circulation during the entire operating period and shall be a closed system, with its own pump or pumps, and with no inlet or outlet pipe or drain into which fuel oil or similar material can be introduced. Storage tanks shall have a positive means of measuring the quantity therein by gauge, calibrated rod or float. An armored thermometer of adequate range in temperature reading shall be fixed in the bitumen feed line at a suitable location near the discharge valve at the mixing unit.

(C) Feeder for Dryer. Plants shall be provided with accurate, mechanical means for uniformly feeding the mineral aggregate into the dryer so that a uniform product and a uniform temperature may be secured.

(D) Dryer. Plants shall include a dryer or dryers that will continuously agitate the aggregate during the heating and drying process; shall be capable of drying and heating all aggregate to the temperature specified without burning or overheating any portion in supplying the mixing unit continuously at its operating capacity. The dryer shall be equipped with an approved dial scale, mercury actuated thermometer, an electric pyrometer or other approved thermometric instrument so placed at the discharge chute of the dryer as to register automatically or indicate the temperature of the heated aggregate.

(E) Screens. Plant screens, capable of screening all aggregate to the specified sizes and proportions and having normal capacity in excess of the full capacity of the mixing unit, shall be provided.

(F) Bins. The plant shall be equipped with storage bins, protecting the aggregate from the weather, of sufficient size to insure adequate storage of appropriate fractions of the aggregate and the bins shall be so constructed as to prevent overflow of one size into a bin used for another size. Separate dry storage shall be provided for mineral filler when used. Each bin shall be provided with its individual outlet gate, designed and constructed so that when closed there will be no leakage and the gates will cut off quickly and completely.

(G) Bitumen Control Units. Satisfactory means, either by weighing, metering or volumetric measurements, shall be provided to obtain the proper amount of bitumen in the mix within the tolerances specified for the job mix. Suitable means shall be provided, either by steam jacketing or insulating, for maintaining the specified temperature of the bitumen in the pipe lines, meters, weigh buckets, spray bars, and other containers or flow lines.

(H) Dust Collectors. If plants are located in any vicinity where dust may be objectionable to adjacent property owners, or when dust interferes with the efficient operation of the plant, proper housings, mixer covers or dust collecting systems shall be installed. They shall be constructed and operated to dispose of or return uniformly, all or any part of the material collected to the hot elevators as directed.

(I) Scales for Hauling Units. Shall meet the pertinent requirements of Article 20.03.

(J) Safety and Access Requirements. The engineer shall, at all times, have free and easy access to any part of the plant. Adequate and safe stairways to the mixer platform and guarded ladders to other plant units shall be placed at all points required for accessibility to all plant operations. All gears, pulleys, chains, sprockets and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all

times around the truck loading space. This space shall be kept free of drippings from the mixing platform.

(K) Field Laboratory. Shall meet the requirements of Article 05.08.

35.05 BATCHING PLANT. (Special Requirements) **(A) Plant Scales.** Scales for any weigh box or hopper may be either the beam or springless dial type and shall be of a standard make and design, accurate to 0.5 of 1 percent.

When scales are of the beam type there shall be a separate beam with tell-tale indicator for each size aggregate and a tare beam for balancing the hopper. The tell-tale indicator shall start to function when the load being applied is within 100 pounds of that desired.

Dial scales shall be springless, of standard make, designed, constructed and installed so that they will be maintained free from vibration, and of such size that the numerals on the dial may be read at a distance of at least 10 feet. The dial shall be of the compounding type having full complements of index points. Pointers so placed as to give excessive parallax errors shall not be used. The scales shall be substantially constructed and, if not capable of maintaining positive adjustment, shall be replaced when so ordered. All dials shall be so located as to be plainly visible to the operator at all times.

All weighing equipment shall be approved by the engineer and shall be capable of easy adjustment of any working part and shall be sealed prior to initial use, and as often thereafter as the engineer may consider necessary to insure accuracy.

(B) Weigh Box or Hopper. Bin storage shall be provided with tight cutoff gates so that there will be no leakage of the aggregate into the weigh box. If one weigh box is used it shall be of sufficient capacity to hold a complete batch of aggregates without wasting or levelling by hand and shall be so designed that the entire batch will discharge quickly into the mixing unit. Separate weigh boxes may be used, but when used the arrangement shall be such that the aggregate from the separate weigh boxes will discharge cleanly and quickly into the mixer. The weigh box shall be open at the top so that if, in charging, an excess of one size of mineral aggregate is introduced into the weigh box, it may be removed by the operator. The weigh box shall be provided with a close fitting and quick operating cutoff gate so that there will be no leakage of the aggregate into the mixing unit.

(C) Bitumen Bucket. The bucket for weighing the bitumen shall have sufficient capacity to hold not less than 20 percent of the weight of aggregate required for one batch. The specified temperature of bitumen in the pipe lines, meters, weigh buckets, spray bars and other containers or flow lines shall be maintained by steam jackets, so designed that steam will not be introduced into the bitumen, or by properly in-

sulated electrical heating units, or by other means, as approved by the engineer. The bitumen bucket shall be suspended on beam type scales equipped with a tell-tale so that the tare weight of the bucket will be shown for each weighing and the net weight of the bitumen measured accurately to within 0.3 of 1 percent from the weight required. The bucket shall be so arranged that it will deliver the heated bitumen in a thin uniform sheet or in multiple streams to full width of the mixing unit.

(D) Mixing Unit. The mixing unit shall be of the twin-shaft, pugmill batch type and shall have a minimum batch capacity of 2,000 pounds. The number and arrangement of the blades shall be such as to give a uniform and complete circulation of the batch in the mixing unit. Any mixing unit that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixing with the bitumen will be condemned.

The mixer box, if not enclosed, shall be provided with suitable means to prevent loss of dust by dispersion. The mixing unit shall be so constructed as to prevent leakage of contents until the batch is to be discharged and shall be equipped with a lock timing device by means of which accurate control of the mixing cycle can be accomplished. The time of mixing shall be considered as the interval between the time the asphalt is spread on the aggregate and the completed mixture is discharged from the mixing unit.

35.06 CONTINUOUS FLOW PLANT. (Special Requirements).

(A) Aggregate Control Unit. In addition to the specification of bins for all plants, the following requirements are necessary:

Each bin being used shall be so equipped that a uniform head of aggregate shall be maintained in the bin or bins and the feeding units to obtain a uniform flow of aggregate. They shall be equipped with an indicator to show when the level in the bin has reached a certain established minimum. The plant operator shall halt mixing operations when the aggregate level reaches this minimum, and allow the bins to refill. A cutoff system will also be required which automatically stops mixing operations when the minimum level in the bin has been reached. Each bin shall have an overflow spout to control the top level of the aggregate in the bin.

The volumetric proportioning device for each bin containing aggregate shall be equipped with an accurately controlled and calibrated gate or other approved device for volumetrically measuring the dried aggregate as it is fed to the mixing unit and shall be so constructed that the flow of aggregate can be accurately determined and positively controlled. The gates also shall be constructed so that they can be locked or bolted in the position as set by the engineer. Means shall be provided for calibration of gate openings with test samples drawn from the gate and weighed. The contractor shall provide a small plat-

form scale of approximately 500 pounds capacity and containers of adequate size for this purpose.

(B) Bitumen Control Unit. The volumetric proportioning device for the bitumen shall be a rotating, positive displacement, bitumen metering pump with a satisfactory nozzle arrangement at the mixing unit. The operating speed of the pump shall be synchronized with the flow of aggregate to the mixing unit by an automatic interlocking control and the device shall be easily and accurately adjustable to vary the quantity of bitumen delivered to the mixing unit so that the resulting mixture will be uniformly proportioned within the established limits. Means shall be provided for accurately checking the rate of flow of bitumen into the mixture.

(C) Mixer Unit. The plant shall include a continuous mixing unit of an approved twin-shaft, pugmill type, steam-jacketed and capable of producing a uniform mixture within the job-mix tolerance. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixing unit shall carry a manufacturer's plate, giving the net volumetric contents of the unit at the several heights inscribed on a permanent gauge and also giving the rate of feed of aggregate per minute, at plant operating speed. The resulting mixture of the continuous flow plant shall be comparable, in quality and uniformity, to that obtained by the weight batching type of plant.

35.07 ROADWAY EQUIPMENT. (Requirements) **(A) Motor Graders.** Motor graders in good mechanical condition, of adequate tractive power, weighing not less than 20,000 pounds, equipped with mold boards not less than 12 feet in length, may be used to spread bituminized material for levelling and shaping the roadway base section. Other mechanical methods which will secure satisfactory results may be used when approved by the engineer. Levelling and shaping and/or otherwise truing the roadway section, while incidental to, does not compose surface course construction.

(B) Pavers. Spreading, shaping and finishing of the surfacing course or courses of bituminized mixture shall be done by one or more self-contained self-propelled units or pavers, operated in such manner that no supplemental spreading, shaping or finishing will be necessary to provide the Surface Smoothness required. (See Article 35.11). Pavers shall contain an integral, activated screed or strike-off assembly, heated if necessary, and shall be capable of spreading and finishing the surfacing course to not less than the full width of a traffic lane and from $\frac{3}{4}$ inch to 6 inches in depth, true to line, grade and crown of the section specified by the plans. The screed or strike-off assembly shall operate by cutting, crowding or other practical action which is effective on bituminous mixtures without tearing, shoving or gouging and produces a finished surface of uniform texture devoid of segregation. The unit or paver shall be provided with rolling, tamping or other suitable

devices so as to produce a surface course uniformly dense throughout, smooth and free from inequalities and irregularities. The screed shall be adjustable horizontally with an indicating level attached in full view of the operator.

The paver receiving hopper shall have sufficient capacity for dumping trucks to avoid decrease in speed or efficiency of the paver and prevent unnecessary delay of dump trucks during spreading operations. Pavers shall be fitted with mechanical devices, such as equalizing and straightedge runners, evener arms and/or other devices for confinement of the surfacing course edges to true lines and for the purpose of compensating grade and surface irregularities in the base and prevent their reflection in the finished surface. Should conditions indicate the advisability, and when so ordered, a levelling attachment of approved design, capable of extending the paver wheelbase by approximately twice its length, shall be attached to the paver for spreading levelling material and for placing the first course of the surfacing as a step toward developing the finished Surface Smoothness required. Additional paver equipment will include blending or joint levelling attachments for smoothing and adjusting longitudinal joints between abutting strips of surfacing courses and a device for forming beveled edges of the surfacing courses when required.

Pavers shall be equipped with power traction adequate to their efficient operation on ascending grades of 7 percent while pushing a loaded truck; be possessed of quick and positive steering ability and capable of operational speeds commensurate with satisfactory placing of the surfacing course mixture.

(C) Trucks. Trucks, in number consistent with production for hauling bituminous mixtures, shall have tight, clean, smooth metal beds that may be lightly sprayed with an excessive amount of thin fuel oil, paraffin oil or soap solution to prevent the mixture from adhering to the truck beds. Upon completion of spraying, if necessary, any excess amount of such oil or solution remaining in the truck body shall be immediately disposed of before loading the bituminized mixture. Any truck causing excessive segregation of material by its spring suspension or other contributing factors, that shows oil leaks of any magnitude, or that causes undue delays, upon direction of the engineer, shall be discharged from The Work until such conditions are corrected. When the length of haul tends to excessive heat loss of the mixture, or when weather conditions are such as to necessitate such protection, each load shall be covered with a tarpaulin, while in transit, to prevent unnecessary loss of heat and protect the mixture from the weather.

(D) Rollers. Rollers shall be the types specified in Parts (B) and (D) of Article 14.02, except as herein modified. A sufficient number of rollers shall be furnished The Work to provide one roller for each 75 tons of bituminized surfacing being spread per hour, but in no case shall less than two rollers be

provided separate surfacing placing operations. One of the required number of two rollers shall be a self-propelled pneumatic-tired roller which exerts a ground contact pressure not less than 85 psi nor more than 110 psi. Besides self cleaning devices, all types of rollers shall be equipped with suitable means of evenly watering roller surfaces.

35.08 PREPARATION OF AGGREGATE. (A) Aggregates shall be dried and heated at the plant so that when delivered to the mixing unit they shall be at as low a temperature as is consistent with proper mixing and laying and in no case to exceed 325°F. Drying shall continue for a sufficient time and at a sufficiently high temperature, consistent with this specification, to cause the aggregate to become thoroughly surface dry and to the extent that the total moisture content for Types 2 and 3 shall not exceed 1½ percent by weight prior to bituminizing. If the bituminized mixture contains evidence of excessive moisture, the production of the plant shall be regulated in such manner that the aggregate can be properly dried. Immediately after drying, the aggregate shall be screened into the bin sizes specified. All aggregates shall be stored in such manner as to control the temperature within the limits prescribed for mixing and to prevent accumulation of moisture. Additional filler, if required to meet the grading requirements, shall be proportioned and blended with the mineral aggregate before being screened into the separate bins. Filler may be added to the aggregate at the mixing plant by premixing it thoroughly with the other fine aggregates or by feeding it into either the hot or cold elevator. Spreading filler over the tops of the aggregate piles or dumping it into the hoppers at crushing plants will not be permitted.

(B) **Type 1 Plant Mix Surfacing.** It is the objective of this provision to prepare and construct a plant mix surfacing utilizing road mix aggregates. The moisture content of the aggregate used in Type 1 Plant Mix Surfacing shall not exceed 3 percent by weight prior to bituminizing.

Aggregate for Type 1 Plant Mix Surfacing shall conform to Article 35.03.

Separation of the aggregate into fractions at the plant will not be required. Delivery of aggregate to the plant shall be from a stockpile, prepared in advance of the mixing operations. The stockpile always shall contain a quantity of material sufficient for one day's operation of the mixing plant. In no instance will it be permissible to charge the plant directly from the crushing and/or screening plant. Extreme care shall be exercised in the selection of the materials in order that the aggregate delivered to the plant will be uniform in grading and will not contain any deleterious material.

The aggregate for the bituminous mixture will be sampled and tested immediately upon delivery from the drying unit. Should there be any oversize material, or an excess of material passing the No. 200 mesh sieve present, the mixing plant

shall be so regulated that the oversize material and excess material passing the No. 200 mesh sieve can be removed prior to preparing the bituminous mixture.

(C) Type 2 Plant Mix Surfacing. Aggregate for Type 2 Plant Mix Surfacing shall conform to Article 35.03. After drying, and prior to mixing with the bituminous material, it shall be separated by screening it into at least two sizes, and stored in separate bins. One bin shall contain that portion of the aggregate retained on the No. 4 sieve and one bin shall contain that portion of the aggregate passing the No. 4 sieve. There shall be no carryover of either size aggregate into opposite bins at any time. The two sizes shall later be combined in the directed proportions upon charging the mixing unit.

(D) Type 3 Plant Mix Surfacing. Aggregate for Type 3 Plant Mix Surfacing shall be of the Type and Grade stipulated in the proposal. After drying and prior to mixing with bituminous material it shall be separated, by screening, into three or more bins as specified and stored in separate bins.

35.09 PREPARATION OF BITUMINOUS MIXTURE. The hot aggregate, prepared as herein prescribed, shall be accurately measured and conveyed into the mixing unit in the proportionate amounts of each aggregate required to meet the specified grading. The aggregate shall be introduced into the mixing unit at a temperature of (a) not more than 225°F. when cut-back liquid asphalt is used and (b) not more than 325°F. when asphalt cement or slow-curing liquid asphalt is used. IN NO CASE shall the aggregate be introduced into the mixing unit at a temperature more than 25°F. above the temperature of the bitumen.

When batch type mixing units are used the mixture shall be made by first charging the mixing unit with the mineral aggregates and dry mixing for a period of 5 to 10 seconds after which the bituminous material shall be added and the mixing continued for a period of not less than 35 seconds, or longer if necessary, to produce a homogeneous mixture in which all particles of the aggregate are uniformly and thoroughly coated.

When continuous flow type plants are used, unless otherwise required, determination of mixing time shall be by weight under the following formula. The weights shall be determined for the job by tests made by the engineer.

Mixing time in seconds shall be equal to "pugmill dead capacity in pounds" divided by "pugmill output in pounds per second." In no case shall the mixing time be less than 40 seconds.

The pugmill blades shall be capable of adjustment so as to retard the flow of material through the mixing unit as may be required to produce a homogeneous mixture in which all particles of the aggregate are uniformly and thoroughly coated.

In order to prevent segregation, loading of the bituminous mixture from a continuous flow type plant into trucks shall be at the rate consistent with the full discharge of the mixing unit.

35.10 CONSTRUCTION METHODS. **(A) Weather and Seasonal Limitations.** Plant mix bituminous surfacing shall be placed only during daylight, when the air temperature is 40°F. and rising and the road surface is dry. The mixture shall not be placed when, in the opinion of the engineer, the weather or road conditions are unfavorable.

(B) Existing Surface Preparation. When not included in the other phases of a contract, preparation of the existing surface shall be performed in accordance with the pertinent requirements of Subsection 16.10.

(C) Prime or Tack Coat. When directed, a tack coat or prime coat of bituminous material shall be applied in the amount and over the area designated.

(D) Protection of Traffic and Roadway Structures. **(1)** Traffic Protection shall be performed in accordance with Schedule 1, Article 16.31.

(2) Protection of Highway Structures. Shall be performed in accordance with Article 33.05.

All equipment shall be removed from the road at the conclusion of the day's work.

(E) Transportation and Delivery of Mixture. Upon being discharged into the hauling unit, the bituminous mixture shall be weighed on previously described scales and transported from the plant to the point of placing in pneumatic-tired vehicles hereinbefore described. The bituminous mixture shall be delivered to the point of use at such temperature between 200°F. and 325°F. as the engineer may direct. When the mixture is being placed during warm weather and the engineer has determined that satisfactory results can be obtained at lower temperatures, he may direct that lower temperatures than those specified may be permitted.

(F) Placing Plant Mixed Surface Course. Levelling material or surface course construction on irregular or small areas, approaches, turnouts, etc., not readily accessible to a paver may be spread and finished by a motor grader, or it may be placed, raked and levelled by hand methods, as directed. All surface course or courses shall be spread, levelled and finished to line and grade and in conformance with the typical section and Surface Smoothness required.

Placing of the plant mixed surfacing material in any section of roadway shall commence at the point furthest from the mixing plant and proceed continuously toward the plant.

Plant mixed surfacing material shall be delivered to the job and spread at the minimum workable temperature which will produce the density and texture described herein, after final rolling. Unless otherwise specified in the plans or proposal, plant mixed surfaces shall be constructed in two or more courses of approximate equal compacted thickness with the "first course" being slightly greater in depth than the "final course."

Sequence of construction "first" and "final" courses shall be practical to the contingencies of operational, construction or weather conditions existent or occurring upon the Project which might be reflected detrimentally or beneficially in the quality of the completed surfacing. Placing of the "final" course shall follow "first" course construction, not later than that time, when it is determined by the engineer that proper bonding of the two courses is obtainable.

One edge of the surfacing course being spread shall be marked by the contractor with a string or wire, based on controls established by the engineer, in advance of spreading any course. Placing of any course shall be as continuous as possible and the roller shall pass over the unprotected edge of freshly spread mixture only when spreading of this course is to be discontinued for such length of time as to permit the mixture to become chilled.

In these cases, including the formation of joints as hereinafter specified, provisions shall be made for proper bond with the new surface for the full depth of the course. Joints shall be formed by cutting back on the previously spread course in order to expose its full depth. When spreading of the course is resumed, the exposed edge of the joint shall be painted with a thin coat of approved bituminous material. The freshly spread mixture shall be raked against the joint, thoroughly tamped with hot tampers and rolled.

The mixture shall be spread and laid with a minimum of cold, longitudinal joints between finished lanes. The lanes shall be as long as practicable in order that hot, longitudinal joints can be made at all times between successive lanes during the progress of the day's run. Longitudinal and transverse joints shall be formed with utmost care and precision of workmanship in order that there will be a complete bonding of the courses and coincidence to surface planes devoid of ridges or depressions at the joints, which will not be tolerated. Joints accumulating dust, mud or other foreign matter shall be trimmed back sufficiently to permit proper bonding of the abutting courses. All concrete or metal structures, such as curbs, gutters, manholes, inlets, valve boxes and headers, shall be painted with a thin coat of bitumen, approved by the engineer, on the area which will be covered by plant mix material.

Where mechanical methods do not produce the proper bond at joints, gutters, curbs or structures, hand methods will be required for filling, spreading, raking and tamping in obtainance of satisfactory results. Hauling over surfacing already placed will not be permitted until the mixture has been thoroughly compacted in the manner specified and it has cooled to atmospheric temperature.

(G) Compaction. In order to develop the specified thickness, the weight of mixture in place per square yard shall be

adjusted to provide the compacted thickness specified. The compaction shall be estimated from the formula:

(a) $W = 0.85 \times G \times 62.4 \times 0.75$ or
(b) $W = 0.85 \times G \times 62.4 \times 0.90$

Where: (a) W = The compacted weight per square yard of the bituminous mixture one inch in thickness

or (b) W = The compacted weight per square yard of the bituminous mixture 0.1 foot in thickness

G = The specific gravity of the mineral aggregate

62.4 = Factor for converting a cubic foot of water to pounds

Compaction operations shall be performed in accordance with the pertinent requirements of Article 14.03(A), except as herein modified.

Generally, unless otherwise directed by the engineer, the compaction operation will be divided into three phases as follows:

- (1) Initial or "break-down" rolling with a smooth steel-wheeled roller.
- (2) Compaction rolling with self-propelled pneumatic-tired roller.
- (3) Final or finish rolling with tandem steel-wheeled roller.

For all phases of rolling, and especially in the case of Phase (1), the rolling shall start at the sides and proceed longitudinally toward the center of the lane or high side, overlapping on successive trips by at least one-half of the rear or two rear wheels in the case of a pneumatic-tired roller. The speed of steel-wheeled rollers shall not exceed three miles per hour and at all times be slow enough to avoid displacement of the mixture. The speed of pneumatic-tired rollers may be in excess of three miles per hour but never so high as to be hazardous or cause movement or displacement of the mixture. All rollers shall be operated by competent and experienced operators. They shall be kept in continuous operation, as nearly as practicable, in such manner that all parts of the pavement shall receive substantially equal compression. Stops or reversal of direction shall not be made in the same transverse location of each pass. Any displacement occurring thereof or from any other cause shall be corrected at once by use of fresh mixture and hand raking and smoothing.

Initial rolling (Phase 1) shall be done as soon after the surfacing material has been spread as the mixture will bear the weight of the roller without undue displacement or ap-

pearance of transverse cracking or hair checking. The break-down roller shall progress with the drive wheel of the steel-wheeled roller forward in the direction of paving. When excessive grade is encountered, the tiller wheel may be used in front so as to partially compact the material for the driver wheel to proceed over and not leave a rough surface caused by chatter. Initial rolling shall generally consist of one complete coverage over the surface. Delays in rolling freshly spread mixture will not be tolerated.

Phase 2 rolling shall follow Phase 1 as soon as possible, providing there is not an excessive amount of pickup on the rubber tires. Rolling shall continue until a minimum of four complete coverages has been accomplished and the required density has been obtained.

Final and finish rolling of the course (Phase 3) shall be accomplished only with a tandem roller of the type and kind hereinbefore specified and as directed by the engineer. This rolling shall proceed continuously until all roller marks are eliminated. After final rolling, the finished course shall, at no point, have a density less than that required and shall have a smooth surface true to grade and typical section. Any low or defective places shall immediately be remedied by cutting out the mixture at such spots and replacing it with fresh mixture, which shall immediately be compacted to conform with the surrounding surface area and shall be thoroughly bonded to it at all points of contact.

35.11 SURFACE SMOOTHNESS. The finished surface shall be free from defects and depressions exceeding $\frac{1}{8}$ inch, as measured with a 10 foot straightedge, paralleling the center of the roadway and shall have an entirely smooth riding quality.

35.12 METHOD OF MEASUREMENT. (A) Plant mixed surfacing material composed of all ingredients in the completed mixture, will be measured by the ton of 2,000 pounds, after mixing, weighed in the hauling unit on specified scales.

(B) Bituminous material will be measured in accordance with Article 30.04.

(C) Other contract items will be measured in accordance with the requirements of the respective specifications.

35.13 BASIS OF PAYMENT. Plant mixed surfacing material, used in the completed and accepted work, will be paid for at the contract unit bid price. This price and payment, except as may be otherwise specified, shall be full compensation for The Work as specified, excepting the bituminous material.

Bituminous material used in the accepted mixture and for tack or prime coat will be paid for at the contract unit bid price, in accordance with Article 30.05.

Bituminous material used in painting joints, gutters, headers, manholes, curbs, etc., covered in Article 35.10(F) will

be paid for at the contract unit bid price in accordance with Article 30.05 and shall include all operations necessary to complete The Work.

"Existing Surface Preparation," unless otherwise specified, will not be paid for separately but will be considered necessary and incidental to the performance of and payment for the other items of the contract and shall include all operations necessary to complete The Work.

Other contract items will be paid for at the contract unit bid prices, in accordance with the requirements of the respective specifications.

SECTION 36

SEAL COAT

36.01 DESCRIPTION. "Seal Coat" shall consist of a surface treatment composed of a single application of bituminous material on an existing bituminous surface, immediately followed by covering with aggregate of the type stipulated in the proposal or shown on the plans, in conformity with the plans for the work thereof and the specifications. When stipulated in the proposal or in the plans, the bituminous material may be applied without cover.

36.02 MATERIAL. (A) Bituminous material of the kind and grade stipulated in the proposal or shown on the plans shall meet the requirements of Section 30. It is understood that the variables of natural conditions and materials, which it is not possible to predetermine, may develop the requirement for adjustments of the application rate of bitumen during the course of The Work.

(B) Cover aggregate may be produced under the contract for seal coat or it may be obtained from stockpiles produced under a previous contract, as stipulated in the proposal or shown on the plans. It is understood that the variables inherent of materials and natural conditions, which it is impossible to predetermine, to be encountered in performing this work, may develop the requirement for adjustments in the application rate of cover aggregate during work performance.

(C) Quantities of bitumen and aggregate will be as specified in the plans or as directed.

36.03 EQUIPMENT. The equipment used in this operation shall comply with the pertinent provisions of Article 33.03 and with references made therein.

36.04 CONSTRUCTION METHODS. (A) General. Seal coat operations shall not be performed prior to May 15th, nor shall

they be commenced later than September 15th, unless authorized in writing by the engineer.

No bituminous material shall be applied when the roadway surface is damp or wet, or when the atmospheric temperature, or the temperature of the oil mat to which the material is being applied, is less than 65°F., and rising, or weather conditions are such that the bitumen will become chilled before the cover material can be spread and rolled. Work shall not be started without consent of the engineer and shall be promptly terminated in the event of rain or the occurrence of unfavorable road or weather conditions.

In no event shall the seal coat be placed on newly constructed or reconditioned surfaces in less than 10 days after such surface has been constructed. Bitumen and aggregate for seal coat shall not be placed upon a plant mix bituminous surface sooner than twenty-one (21) days after placement of said surface, unless the engineer directs otherwise.

When directed by the engineer, the cover aggregate for any course may be wetted by watering, prior to spreading it upon the bituminous material.

(B) Sweeping. Directly in advance of the first application of bituminous material, the roadway surface shall be swept clean of all dust, dirt, or foreign matter, by means of a power broom, blower or hand brooming, when required for satisfactory cleaning of the surface. Water washing may be required to remove agglomerated clay, shale or other material that resists removal by mechanical or hand methods.

Such cleaning will not be measured nor paid for directly but shall be considered incidental to the other items of the contract.

If the surface texture on which the seal coat is being constructed is such as to permit rapid absorption, the engineer may direct a preliminary application at a rate of approximately one-tenth (0.1) gallon per square yard of the type bitumen as specified for the seal coat. Such application will be measured and paid for as provided under Articles 33.06 and 33.07.

(C) Application of Bitumen. Immediately following the cleaning, the first application of bitumen shall be uniformly applied, at the application temperature and at the rate per square yard directed by the engineer, by means of a pressure distributor of the type described. Extreme care shall be taken in application of the bitumen to secure uniform surface cover and true lines.

(D) Application of Cover Aggregate. The contractor shall not proceed with the application of bitumen until a supply of aggregate sufficient to cover the entire application is immediately available for covering the bitumen in less than five minutes. Spreading of cover material shall be made promptly on the freshly spread bitumen, when the engineer determines

that its consistency has become such that the best "keying" results will be obtained. In the instance of an emulsified asphalt type of bituminous material, cover aggregate shall not be applied until the emulsion starts to "break" and it begins to turn black in color.

The bitumen application shall be promptly covered with the specified cover material, at the rate directed by the engineer, spread uniformly over the bitumen with a self-propelled or truck mounted mechanical spreader, with rate of application control independent of the motive power previously approved by the engineer. Aggregate spreaders that fail to make a uniform and satisfactory distribution of material shall be promptly removed from further use. Special care must be exercised in the spreading of cover material in order that uniformity of cover and longitudinal lines will be secured. Operation of the spreader motive equipment shall, at all times, be assigned to the same experienced operator.

Brooming by mechanical or hand methods, if directed by the engineer, shall be employed to insure uniform distribution of the cover material. When brooming is resorted to, particular caution must be exercised to avoid displacement or loosening of particles of cover material from the bitumen.

Bituminous material application shall not be made to such a distance that uncovered bitumen in "meet line" areas will become chilled to such extent during the time interval, that it will not successfully "key" the maximum amount of cover aggregate. Bitumen must be applied in such manner and with such care that transverse and longitudinal joints or "meets" of successive applications will not result in ridges or depressions and will be smooth, consistent with the adjacent surface of the completed treatment.

Longitudinal laps (meet lines) may be from 6 to 10 inches in width, but there shall be no overlap at the end junction of applications. In order to prevent lapping at transverse junctions, the distributor shall be promptly shut off and, if necessary to prevent dripping, a drip pan shall be inserted under the nozzles when the application begins to thin. Before continuing application of the bitumen, building paper or metal sheets shall be spread over the treated surface for sufficient distance back from the joint on the cover aggregate so that the sprayers are operating at full force upon reaching the surface to which application is to be made. The bitumen application shall be stopped or shut-off on paper or metal sheets. Any paper used for covering joints shall be removed and destroyed.

All transverse joints shall be covered with aggregate and shall be broomed back before the next longitudinal application of bitumen is made. When it is necessary to cover "meet lines" to permit trucks or traffic to cross over, such cover aggregate shall be neatly broomed back exposing the full width of the "meet line" before the abutting application of bitumen is made.

There shall only be permitted a minimum number of "meet lines," compatible with the width of the roadway surface. Permission may be granted by the engineer to make full road surface width application of bitumen and cover aggregate, to be performed in a single continuous operation, so coordinated that the movement of public traffic will not suffer greater inconvenience than that resulting from strip or half roadway width methods.

(E) Rolling. Rolling of cover aggregate shall be in accordance with Article 33.04(E).

(F) Opening to Traffic. Upon completion of this cover aggregate course, the surface shall be opened to traffic for a period of 2 days, with the period of specified traffic control in effect. During this period the surface shall be maintained by brooming and rolling, as directed by the engineer. Any holes or breaks that may occur shall be satisfactorily repaired. Any areas showing excess bitumen shall be covered with aggregate and rolled. Any irregularities influencing the stability and riding quality of the surface shall be corrected in satisfactory manner. Cost of any such repairing or corrections shall not be paid for directly but shall be included in the other bid items in the contract.

Trucks hauling cover material to the spreader units or traffic shall not be permitted at any time, or under any circumstances, to cross over or to drive on any uncovered bituminous material. When operating over freshly spread cover material, the speed of vehicular traffic shall be so regulated that loosening and displacement of cover material shall not occur. Trucks failing to observe this requirement shall be promptly dismissed from The Work.

36.05 PROTECTION OF TRAFFIC AND HIGHWAY STRUCTURES. The requirements and provisions of this article shall be the same as those set forth under Article 33.05.

36.06 METHOD OF MEASUREMENT. **(A)** Bituminous material used in the completed and accepted work will be measured by the U. S. Gallon, or by the ton, as stipulated in the proposal and in accordance with Section 30.

(B) Cover material used in the completed and accepted work will be measured by the ton on scales furnished by the contractor, or by the cubic yard, measured in the vehicle at point of delivery on the roadway, as stipulated in the proposal and in accordance with Section 20.

(C) Rolling will be measured and provided for in Section 14.

(D) Other items specified in the contract will be measured as stipulated in the proposal.

(E) Traffic Protection will not be measured unless specified otherwise.

36.07 BASIS OF PAYMENT. Application of bituminous material, cover aggregate, rolling, and any other items specified in the contract will be paid for at the contract unit price bid for the unit specified in Article 36.06 or the proposal, which prices and payment will be full compensation for furnishing all materials, except production of aggregates, and performing all operations necessary to complete The Work, including maintenance of the completed surface until accepted. Aggregates produced under this contract will be specified under Section 27. Wetting of cover aggregates, will be done by the contractor, when directed, at no extra cost to The Commission.

SECTION 39

PORTLAND CEMENT CONCRETE PAVEMENT

39.01 DESCRIPTION. "Portland Cement Concrete Pavement" shall consist of a single course of air-entrained Portland cement concrete, with or without reinforcement, constructed on a foundation course or on a prepared subgrade in accordance with the specifications and in conformity with the lines, grades, thicknesses and cross sections shown on the plans or as directed.

39.02 MATERIAL. (A) Concrete. Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, an air-entraining agent and water, and shall conform to the requirements for Class "AP" concrete, as specified in Section 46, unless specified otherwise on the proposal form and as may be modified by the special provisions.

(B) Cement. Portland cement shall conform to AASHO M 85, Type II, unless specified otherwise. "Cement" also shall conform to Article 46.04(A)(1) unless modified.

(C) Air-Entraining Admixtures. Air-entraining admixtures shall be in accordance with AASHO M 154 and as may be modified. The air content shall be not less than four percent nor more than six percent as determined by AASHO T 152.

(D) Fine Aggregates. The fine aggregate shall conform to Article 46.04(C)(1).

(E) Coarse Aggregates. The coarse aggregate shall conform to Article 46.04(C)(2).

(F) Water. Water used in concrete shall conform to Article 46.04(B).

(G) Reinforcing Steel. Steel-wire fabric or steel bar mats, when called for, shall be of the sizes and dimensions and lo-

cated as shown on the plans. Steel-wire fabric reinforcement shall conform to AASHO M 55. It shall be furnished in flat sheets. Bar mats shall conform to AASHO M 54 and the bars used shall conform to AASHO M 31, structural or intermediate grade, as specified.

(H) Dowel Bars. The dowel bars shall be plain round bars of intermediate grade open-hearth steel conforming with AASHO M 31. The dimensions of the bars and their positions in the pavement shall be as shown on the plans or as directed.

(I) Tie Bars. Tie bars shall be bars of structural or intermediate grade open-hearth steel conforming to AASHO M 31. They shall be of an approved deformed type, but they shall not be the cold twisted type. The length, size and spacing of the bars shall be as shown on the plans or as directed.

(J) Expansion Joint Filler. Expansion joint filler, wherever called for on the plans, shall conform to AASHO M 90 or AASHO M 153. AASHO M 90, redwood board expansion joint filler, generally will be used for all newly constructed expansion joints. AASHO M 153, preformed expansion joint filler, will usually be used at joints between the concrete pavement and structure in place.

(K) Joint Sealing Material. The sealing material for sealing all types of pavement joints shall be a hot poured thermoplastic rubber or rubber asphalt compound complying with Federal Specifications SS-S-164, and shall be furnished in one grade only. Ready mixed cold applied joint fillers for sealing joints in concrete pavement will not be permitted except by prior written approval of the engineer.

The Commission reserves the right to order discontinued the use of any joint filler material which, in the opinion of the engineer, fails to produce a satisfactory joint under the methods employed by the contractor.

(L) Subgrade Paper. Subgrade paper, if called for on the plans, shall conform to AASHO M 74.

(M) Foundation Course. When a foundation course is called for, it shall be pit run gravel, shale, scoria, sand, disintegrated granite, crushed gravel or stone and filler, or similar materials from authorized sources designated by the engineer, and shall conform to the pertinent provisions of Sections 20, 21, 22, 23, 24, or 25, whichever is called for in the proposal form. This item shall be placed and compacted in conformity with the lines, grades and sections shown on the plans. Granular or soil materials adequately stabilized with a cementing agent may also be used as directed.

(N) Shoulder Surfacing Material. Shoulder surfacing material shall be material specified under Part (M) above or called for in the special provisions, and shall be placed and compacted in conformity with the lines, grades and sections shown on the plans.

(O) Curing Compound. Curing compound, when used, shall conform to AASHO M 148, Type 2, white pigmented, liquid membrane-forming compound.

(P) Composition and Proportioning of Materials. The composition of the concrete and the proportioning of the materials shall conform to Article 46.03(B), Method "B".

39.03 EQUIPMENT. **(A) Preliminary.** Before paving operations are started, the contractor shall have at the site and on the Project, all equipment necessary for the proper preparation of subgrade, batching, paving, finishing and curing and all tools necessary for performing all parts of the work. The equipment shall be checked for mechanical condition and adjustment and the design, capacity and mechanical condition shall be approved by the engineer before any paving work is started. During paving operations, the contractor shall maintain all equipment in proper working order and adjustment and shall make any needed resetting or readjustment of the equipment, whenever required by the engineer, and if any equipment proves inadequate to obtain the results specified, such equipment shall be made adequate or other equipment shall be substituted which will obtain the specified results.

(B) Water Supply. When necessary for the supply of water for all operations described in the specifications, an adequate pipe line along the improvement, or sufficient tank capacity, shall be provided by the contractor. Any pipe line used must be fitted with drains at the low points and air relief valves at the high points and with convenient outlets for all paving operations.

The concrete pavement in place for five days after placing and the subgrade or foundation course preparation shall have prior rights to the water supply. If it should develop that there is not sufficient water for all purposes, the concrete mixer shall be shut down until the water needs of the curing and subgrading operations have been cared for.

(C) Side Forms. Side forms shall be metal unless otherwise specified. Metal forms shall be of sufficient weight and strength to resist the pressure of the concrete and be of a design that can be rigidly held to proper line and grade.

Flexible or curved forms of proper radii shall be used for curves of one-hundred feet radius or less. All side forms shall be heavy enough to support mechanical finishing machines, mechanical subgrader or similar heavy equipment. They shall be equipped with a device for holding abutting sections firmly in alignment, which device shall permit adjustment for horizontal and vertical curves. Forms eight inches or more in height shall be at least eight inches wide at the base; and in no case shall the width of the base be less than eighty (80) percent of the height; forms less than eight inches in height shall have a base width at least equal to the height of the forms. They shall be equipped with not less than three staking points

per each ten feet of length with means of securely locking the form to each stake. Flange braces and staking pockets shall extend outward on the base not less than two-thirds of the height of the form.

The use of wooden forms will not be permitted except by written consent of the engineer and then only in case of necessity. When used, side forms of wood shall conform to the requirements for steel forms as to lines, grade and height.

39.04 CONSTRUCTION METHODS. **(A) Preparation of Subgrade or Foundation Course.** After the roadbed has been finished and compacted in accordance with the requirements of Section 11, the subgrade, or foundation course if called for, shall be placed, trimmed, shaped and compacted to the lines, grades and cross-sections shown on the plans or staked by the engineer and for an additional distance of two feet on each side, beyond the pavement width, and in accordance with Section 20. The surface of the subgrade or the foundation course shall conform to the lines, grades, crown and cross-sections shown on the plans and to the requirements of Article 20.06, prior to setting the forms.

After the forms have been set and approved by the engineer, the subgrade or foundation course shall be reshaped and recompacted by accepted rollers or compactors operating between the fine grading equipment and the paver. The subgrade or foundation course shall be tested in advance of the paver for crown, profile elevation and surface smoothness, by the use of an approved template held in a vertical position and moved backward and forward on the forms. The template shall be mounted on visible rollers and shall be designed so that its toothed edge conforms to the required shape of the subgrade and so that, when riding vertically on the forms, the toothed edge will represent the subgrade surface. Any excess material represented by this template shall be removed. Low areas likewise found shall be brought up to correct elevation with approved subgrade or foundation material and compacted to the density specified for the embankment.

Equipment used in such a manner as to cause ruts in the finished subgrade or foundation course shall be corrected or removed from The Work. The finished subgrade or foundation course shall be maintained in a smooth, compacted and undisturbed condition until the pavement is placed.

The subgrade or foundation course shall be in a moist but not muddy condition at the time of placing the concrete. If required by the engineer, it shall be wetted the previous night or not less than six hours previous to the placing of the concrete. If it subsequently becomes dry, the subgrade or foundation course shall be sprinkled, but the method of sprinkling shall not be such as will form mud or pools of water.

(B) Form Setting. The forms shall show no variation greater than one-eighth ($\frac{1}{8}$) inch from the true plane of the

face or top of the forms. The forms shall be free from warp, bends or kinks.

The foundation course or the subgrade, under the forms, shall be hard and cut true to grade so that the form, when set upon it, will be firmly in contact for its whole length and exactly at the desired grade. Any foundation course which, at the form line, is found below the established grade shall be filled to grade in lifts of one-half inch or less for a distance of eighteen inches on each side of the base of the form and thoroughly compacted to the specified density. Imperfections and variations above grade shall be corrected by compacting or be thoroughly compacted after the form is set. No settlement or springing of forms under the finishing machine will be tolerated.

Conformity of the alignment and grade elevation of the forms with the alignment and grade elevation shown on the plans shall be checked, and any necessary corrections made by the contractor immediately prior to placing the concrete. Where any form has been disturbed or any foundation course thereunder has become unstable, the form shall be reset and rechecked.

Forms shall be set not less than five-hundred (500) feet in advance of the point where the concrete is being placed to insure proper construction and inspection of the foundation course. Forms shall remain in place at least twelve (12) hours after the concrete has been placed against them unless earlier removal is necessary to permit sawing of transverse weakened plane joints. Forms shall be cleaned and oiled each time they are used. The contractor shall exercise extreme care in removing forms to avoid any damage to the pavement edges.

(C) Proportioning and Measuring. (1) The concrete shall conform to the mix designed by the laboratory which will produce concrete having a minimum strength of four-thousand (4,000) psi at twenty-eight (28) days using not less than six (6) sacks of cement per cubic yard and not more than six gallons of water per sack of cement . . . it being understood that the proportions may be changed during the progress of the work and that they shall at no time be such that not more than 10% of the test cylinders of the resultant concrete will show compressive strengths of less than the design strength of four-thousand (4,000) pounds at twenty-eight days.

(2) Measuring materials for job mixed concrete. Each kind of aggregate for each batch shall be weighed accurately and separately in an approved weighing device.

(3) Cement in unopened bags as furnished by the manufacturer may be considered to weigh ninety-four pounds. All cement must be weighed where batches are used that require fractional bags of cement.

(4) Water measuring equipment shall be accurate to within one quart. The water storage tanks shall be so arranged

that the measurement will not be affected by variations of pressure in the water supply line and will be accurate under all construction conditions.

(5) Scales for weighing aggregates and cement may be either horizontal beam or springless dial type designed as an integral unit of the batch plant, of rugged construction to withstand hard usage due to working conditions with an allowable error of one-half of one percent of net load with significant graduation down to five pounds. When beam scales are used, provisions such as telltale dial shall be made for indicating to the operator that the required load in the weighing hopper is being approached, which device shall indicate at least the last one-hundred pounds of load. Convenient means shall be provided for removing an overload from the hopper. Beam scales which are used for weighing more than one aggregate shall have an independent beam for each material being weighed. Scales shall be checked to assure accuracy after installation and before any proportioning of concrete begins.

(D) **Consistency.** The consistency of concrete shall be measured as described in AASHO T 119. The slump of the various types of concrete for pavement shall be as follows:

Non-vibrating—machine finishing	1½" to 2½"
Non-vibrating—manual finishing	2 " to 3 "

(E) **Vacant.**

(F) **Mixing.** Either a central mixing plant or a central proportioning plant shall be used. The practice of distributing aggregate along or upon the roadway and feeding from there directly into the mixer will not be permitted.

Concrete shall be mixed in a batch mixer of approved type and capacity for a period of not less than one minute after all the materials, except water, are in the drum. The mixer shall be operated at drum speed shown on the manufacturer's name plate. Any concrete mixed less than the specified time shall be dumped outside The Work and removed at the contractor's expense. Except by written permission of the engineer, the mixer shall not be operated in excess of its guaranteed capacity as shown on the standard rating plate on the machine. Pick-up and throwover blades in the drum of the mixer, which are worn down three-quarters of an inch or more in depth, shall be replaced by new blades. The minimum mixing time, after all materials have been placed in the drum, shall be one minute. The intermingling of batches will not be permitted. The skip and the throat of the drum shall be kept free and clean.

The mixer shall be equipped with an approved timing device which will automatically lock the discharge lever and release it only at the end of the mixing period; the device shall be equipped with a bell or other audible device adjusted to make an appropriate noise each time the lock is released. Failure of the timing device shall be cause for the discontinuance

of the use of the mixer until the device is repaired or a new timer substituted. The mixer may be used temporarily, however, providing the mixing time is increased fifty percent and a suitable watch or clock is placed in full view of the mixing operator.

Retempering concrete by adding water or by other means will not be permitted. Concrete not in place within forty-five minutes from the time the ingredients were charged into the mixing drum, or that has lost plasticity to the extent that it will not meet slump requirements, shall not be used. High early strength cement concrete will be subject to further appropriate limitations. Concrete shall not be mixed during cold weather. Materials containing frost shall not be used. Fine aggregate containing lumps or hardened material shall not be used.

Suitable equipment for discharging and spreading the concrete on the subgrade shall be provided.

(G) Transporting Concrete. Transit-mixed concrete or concrete mixed in a central mixing plant shall be mixed and transported in accordance with ASTM C 94 and may be used only when approved in writing.

When a central proportioning plant is used the loose cement may be placed in batch boxes between the coarse and fine aggregate, provided that the batch boxes so loaded, which stand more than five hours and less than eight hours, shall have additional cement added thereto in an amount equal to twenty-five percent of the standard quantity required, and batch boxes which stand eight to twelve hours shall have additional cement added thereto in an amount equal to fifty percent of the standard quantity required. Materials in batch boxes, so loaded, which stand more than twelve hours shall not be used. Where such method of loading is used, loaded batch boxes shall be suitably covered to exclude water in case of rain and to prevent loss of cement due to wind. Alternate methods of loading batched aggregates and cement must be approved, in writing, prior to use.

(H) Placing Concrete. The concrete shall be distributed to such depth above the grade that, when consolidated and finished, the slab thickness required by the plans will be obtained at all points and the surface will not at any point be below the grade specified for the finished surface.

Concrete shall be placed only on a foundation course, or subgrade, which has been approved. Concrete shall not be placed on a frozen foundation course or subgrade. At all times during operation, at least five-hundred feet of foundation course, or one day's run of concrete shall have been prepared ahead of the mixer. No concrete shall be placed around manholes or other structures until they have been brought up to the required grade and alignment.

The concrete shall be deposited on the foundation course, or subgrade, in such a manner as to require as little rehandling

as possible. Concrete along the forms shall be consolidated by vibration. Vibrators attached to the rear of the spreader or operated by hand from outside the forms will be permitted. Care shall be taken to insure that the concrete is not excessively vibrated.

Placing shall be continuous between transverse joints without the use of intermediate bulkheads.

Whenever it becomes necessary to stop the mixer, hand mixing shall be resorted to if necessary and a transverse construction joint shall be constructed as shown on the plans and as hereinafter specified. Except as above provided, no joint of any kind shall be placed across the pavement at any other location, then that directed or shown on the plans. The pavement shall be constructed to its full width of the lane in a single construction operation. Longitudinal joints between lanes or sections shall be constructed in accordance with the details shown on the plans. Concrete in a longitudinal section shall not be placed until the adjacent parallel slab has attained an age of fourteen days or has attained a compressive strength of at least 4000 lbs./sq. in. as shown by tests of standard specimens cured under the same climatic and moisture conditions as the slab. The mixer shall be located outside the lane of pavement being laid unless otherwise permitted, in writing, by the engineer.

(I) Slip-Form Paver. A slip-form paver may be used, in lieu of forms, provided the equipment and the proposed methods of operation are given prior approval by the engineer and subject further to the following modifications:

(1) All reference in the specifications to the construction requirements when forms are used shall be deleted and the procedure shall be modified to fit the use of the slip-form paver.

(2) The contractor shall provide such equipment that will prepare the subgrade so as to comply with Article 39.04(A).

(3) The slip-form paver shall be equipped with a vibrator and tamping bar, extending over the full width of the surface and the concrete shall be held at a uniform consistency having a slump of not more than two inches. If, at any time, it is necessary to stop the forward movement of the slip-form paver, the vibrator and tamping elements shall also be immediately stopped. Frequent stopping of the slip-form paver will not be tolerated. The contractor will be required to so organize his forces that a continuous deposit of concrete to the paver will be assured.

(4) The contractor will not be permitted to operate a mixing plant inside of the area to be traversed by the slip-forms that is to be paved.

(5) All contractual and longitudinal joints shall be sawed in accordance with the requirements specified in Part (K) of this Article.

(6) The edge of the slab shall be covered with curing compound as specified in Article 39.02(0).

(J) Handling and Placing Reinforcement. The concrete shall be reinforced if and as designated on the plans. Reinforcing metal shall be kept clean and free from rust, straight and free from distortion, and shall be placed and held in position as detailed. All metal received on the job shall be held in approved storage and only such metal shall be distributed along The Work as is needed for immediate placement.

When bar mat assemblies are shown on the plans, the reinforcement shall be assembled accordingly, firmly fastened together at all intersections. All adjacent ends shall lap not less than forty diameters. Mat assemblies shall be placed by methods satisfactory to the engineer so that no displacement will occur during concreting operations. "Sleds" shall not be used except those shown on the plans and designed so as not to form planes of latent weakness. When steel fabric is required, it shall be placed in strips transversely with the roadway at the depth and with the lap shown on the plans. The fabric shall extend to within two inches of the ends and sides of the slabs. The concrete shall be struck off by means of a template at the indicated depth of the reinforcing below the finished surface of the slab. The fabric reinforcement shall then be placed directly upon the concrete and properly secured so that it will remain in place while concrete is placed above it.

(K) Joints. All costs incidental to the joint construction shall be included in the original contract unit price for "Concrete Pavement."

(1) Transverse Expansion Joints. Transverse expansion joints, when called for, shall be formed during the placing of the concrete and such methods of construction shall be employed that joints to the full depth and width of the slab are secured. The finished joint shall be true to the line prescribed within an allowable variation of one-quarter inch in the width of one traffic lane.

The preformed expansion joint filler shall conform to AASHO M 90, shaped to the dimensions shown on the plans.

A string shall be stretched between the pavement forms along the centerline of the joint. The entire joint assembly shall then be carefully levelled up so that the dowels are held rigidly parallel to the pavement surface and parallel to the centerline of the pavement and free to slide in the dowel holes. Any grease scraped off the dowels in assembling the joint shall be replaced. Any excess grease on the dowel holders shall be removed.

The complete expansion joint assembly shall be placed directly beneath the string line so that the vertical plane of the

joint will be perpendicular to the finished surface of the slab, and at right angles with the centerline of the slab.

Transverse expansion joints of the preformed type shall be formed by securely staking perpendicular to the proposed surface of the pavement and an approved "installing bar" or installing device, against which the preformed filler shall be fastened before placing the concrete.

The installing bar shall be a substantial metal plate or shape and shall have a length of one-half inch less than the proposed width of the slab in cross section with a width of one-fourth inch less than the proposed depth of the slab and shall be staked in position so that the top edge, unless otherwise provided on the plan, will be three-fourths inch below the proposed pavement surface; the lower edge shall be cut to conform to the prescribed cross section of the subgrade; the installing bar shall be slotted from the bottom as necessary to permit the installation of the required dowels and may be further cut away at intervals along its length so as to allow the concrete to make contact with the preformed filler at close intervals. Suitable means shall be provided on the bar for facilitating its removal. Header boards, sheet metal holders or other devices used in lieu of the installing bar shall be approved by the engineer.

The preformed joint filler shall be appropriately punched to admit the dowels. It shall be furnished in lengths of not less than ten feet. Where more than one section is allowed and used in a joint, the section shall be securely laced or clipped together. When in position, the filler shall be accurately perpendicular to the surface of the pavement. The bottom edge of the filler shall project to or slightly below the bottom of the slab and the top edge, unless otherwise prescribed, shall be held about three-fourths inch below the proposed surface of the pavement in order to allow the finishing operations to be executed continuously. The top edge of the filler shall be protected, while the concrete is being placed, by a metal channel cap of at least Gage 10 material, having flanges not less than one-and-one-half ($1\frac{1}{2}$) inches in depth. The installing device may be designed with this cap, self-contained.

Where integral curb is specified by the plans, the joint filler shall provide full thickness of joint filler through the curb and shall be placed at the same position as that in the underlying pavement slab.

After the concrete has been placed on both sides of the joint and struck off, the installing bar shall be slowly and carefully withdrawn leaving the preformed filler in place. Before the installing bar or channel cap is completely withdrawn, the concrete shall be carefully spaded and additional freshly mixed concrete worked into any depressions left by the removal of the installing bar. The filler must be exposed for the full width of the slab. The installing bar shall be cleaned and re-oiled prior to each installation of a joint. After the re-

moval of the side forms, the ends of the transverse joints at the edges of the pavement shall be carefully opened for the entire depth of the slab. Before the pavement is opened to traffic, preformed joints, in which the filler does not come flush with the surface, shall be sealed or topped out with the filler prescribed for poured joints, leaving a neat uniform strip of filler material slightly below the surface of the pavement.

In case the filler material in an expansion joint is tilted or otherwise displaced by the strike-off or finishing machines, the filler and the accompanying dowel bar assembly shall be removed from the pavement and a complete new joint constructed at the same location.

(2) Expansion Joints at Structures. Expansion joints shall be formed at all existing or proposed structures and features projecting through, into or against the pavement and, unless otherwise indicated, such joints shall be three-fourths inch in thickness, for the full depth of the pavement, and shall be the preformed type and shall conform to AASHO M 153.

(3) Transverse Construction Joints. Unless other prescribed joints occur at the same points, transverse construction joints conforming to details on the plans, shall be made at the end of each day's run or where interruption in the concrete operations of more than thirty minutes occurs. An "installing bar" as prescribed for transverse expansion joints shall be used or a clean plank having a thickness of not more than three inches and cut to conform with the plan cross-sections of the slab with a beveled strip to form a keyway joint may be used as a header board. The installing bar shall be carefully removed and any surplus concrete on the subgrade shall be cleaned away and the fresh concrete deposited directly against the old.

(4) Transverse Contraction Joints. Contraction joints shall be of the type and spacing shown on the plans, shall be constructed at right angles to the centerline and perpendicular to the surface of the pavement.

Sawed contraction joints shall be cut by means of an approved concrete saw. The joints shall not be sawed until the concrete has hardened to the extent that tearing and ravelling is precluded. Part or all of the joints shall be sawed before the pavement starts shrinking and before uncontrolled cracking takes place. The spacing of the joints that must be sawed early will depend on several factors but shall be at such intervals that will prevent uncontrolled cracking. Any procedure which results in premature and uncontrolled cracking shall be revised immediately by adjusting the sequence of cutting the joints or the time interval involved between the placing of the concrete or the removal of the curing media and the cutting of the joints.

The joints shall be sawed at the depth, spacing and lines shown on the plans. If there are gutters and curbs they shall

be cut to the proper depth to prevent erratic cracking. Suitable devices or guide lines shall be provided to insure cutting the joint in a straight line and perpendicular to the centerline of the pavement.

All contraction joints in adjacent widths of multiple lanes shall be sawed before uncontrolled cracking occurs. Any procedure which results in premature and uncontrolled cracking shall be revised immediately.

Immediately after the sawing operation is completed the groove shall be flushed out with water under pressure, and then cleaned, with compressed air, of all dust, water and slurry. The groove shall be cleaned again with a strong jet of compressed air just prior to filling the groove with joint filler.

(5) Longitudinal Joints. Longitudinal joints shall be constructed as shown on the plans and all such joints, not made by a form, shall be sawed true to line and perpendicular to the surface of the pavement. Sawing shall conform to the requirements specified for "Transverse Contraction Joints," Part (K)(4).

(6) Keyway Longitudinal Joints. Keyway joints shall be used at the locations shown on the plans where one longitudinal lane of pavement is to be constructed against another separately laid lane of pavement. The keyway joint shall be a tongue and groove joint, the tongue and groove to be of the dimensions shown on the plans.

Construction of the second abutting lane at the keyway joint will not be permitted until the concrete in the first lane has attained a compressive strength (AASHO T 22) of at least four-thousand (4,000) lbs. per square inch.

(L) Consolidating and Finishing. (1) The sequence of operations shall be:

- First — the strike-off and consolidation
- Second — floating and removal of laitance
- Third — straightedging
- Fourth — belting and burlap drag final finish

The machine method of strike-off and consolidation may be employed except that, for areas where the width of slab changes, hand methods will be allowed. All finishing equipment and tools shall be thoroughly clean prior to use and shall be so maintained during their period of use on The Work.

(2) Strike-Off and Consolidation. The concrete, as soon as placed, shall be accurately struck-off and screeded, with approved machine equipment, to the crown and cross-section shown on the plans and to such elevation slightly above grade that when properly consolidated and finished the surface of the pavement shall be the exact grade elevation indicated by the plans.

The machine equipment shall be of the screeding and troweling type, equipped with two independently operated screeds, to strike-off and consolidate the concrete and shall be subject to the approval of the engineer. The machines shall go over each area of pavement as directed and as many times and at such intervals as is necessary to give the proper compaction and to leave a surface of uniform texture, true to grade and crown. Prolonged operation over a given area shall be avoided. The tops of the forms shall be kept clean by an effective device attached to the machine and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation tending to affect the precision finish. The finishing machine shall be of ample strength to withstand severe use and shall be fully and accurately adjustable for loss of crown or other derangement due to wear. At least two trips of the finisher will be required over all pavement areas.

During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length. Except when making a construction joint, the finishing machine shall not be operated beyond that point where the above described surplus can be maintained ahead of the front screed.

(3) Floating. In this operation, a self-powered mechanical float shall be used. It shall be of a type which works with a sawing motion while held in "floating position" and passed gradually from one side of the pavement to the other. Movements ahead along the centerline of the road shall be in successive advances not more than one-half of the length of the float. Its design and manufacture shall be of a type and style which in operation will provide a smooth true section. All mechanical floats or other type of equipment proposed for use in this operation must be approved by the engineer prior to use.

(4) Straightedge Finishing. After the floating is completed, but while the concrete is still plastic, minor irregularities and score marks remaining in the pavement surface shall be eliminated by means of long-handled wood floats and straightedges. When necessary, excess water and laitance shall be removed from the surface transversely by means of a finishing straightedge. The long-handled floats may be used to smooth and fill in open-textured areas in the pavement surface, but the final finish shall be made with the straightedge. The use of long-handled floats shall be held to a minimum as necessary to correct local surface unevenness not taken care of by the float, but it shall not be used to float the entire pavement surface. Straightedges shall be not less than ten feet in length and may be operated from bridges and from the side of the pavement. A straightedge operated from the side of the pavement shall be equipped with a handle three feet longer than one-half the width of the pavement. The surface shall be tested for trueness with a straightedge not less than ten feet in length, which shall be held in successive positions parallel and at right angles to the centerline of the pavement in contact

with the surface and the whole area covered as necessary to detect variations. The straightedge shall be advanced along the pavement in successive stages not more than one-half its length. Depressions shall be immediately filled with freshly mixed concrete, struck-off, consolidated, and refinished. Projections above the required elevation also shall be struck-off and refinished. The straightedge testing and finishing shall continue until the entire surface is free from observable departure from the straightedge, conforms to the required grade and contour and, when the concrete is hardened, will conform with the surface requirements specified under this Article, Part (L)(12), Surface Test.

(5) **Belting.** When most of the water glaze or sheen has disappeared and before the concrete becomes non-plastic, the surface of the pavement, in short increments of length, shall be belted with a two-ply canvas belt, not less than eight inches wide and at least two feet longer than the width of the slab. Hand belts shall have suitable handles to permit controlled, uniform manipulation. The belt shall be operated with short strokes transverse to the paving strip and with continuous advance longitudinally. Belts shall be cleaned as required. The belting shall be carefully done so as to produce a finished surface without leaving disfiguring marks. No tool marks of any kind shall be present in the finished surface.

(6) **Burlap Drag Finishing.** After belting, the surface of the pavement shall be dragged longitudinally in the direction of the concrete placement with a multiple ply burlap drag at least three feet in width and equal in length to the width of the slab. The leading transverse edge of the drag shall be securely fastened to a traveling bridge, leaving at least one foot of the burlap adjacent to the rear edge in contact with the pavement. The drag shall be operated with the burlap moist and shall be cleaned and changed as required. The dragging shall be carefully done so as to produce a finished surface having a fine granular or sandy texture without leaving disfiguring marks. The edges of the slab shall be finished, carefully and neatly with an edging tool, having a radius of one-fourth ($\frac{1}{4}$) inch, before the concrete has taken its initial set. The surface of pavement at joint edges shall be dragged as necessary with a small hand operated drag following edge tooling. No tool marks of any kind shall be present on the finished surface.

(7) **Hand Method, Consolidation.** The contractor shall provide the necessary equipment for hand finishing, both on normal sections and super-elevated sections so that hand equipment will be available for use in case the machine finishing equipment breaks down.

The concrete, as soon as placed, shall be struck-off and screeded to the crown and cross-section shown on the plans and to such elevation above grade that, when consolidated

and finished, the surface of the pavement shall be at the exact grade elevation indicated by the plans.

The entire surface shall then be tamped and the tamping operation continued until the required compaction and reduction of surface voids is secured. A strike-off or tamping template shall be provided on The Work. It shall be durably constructed of three or four inch lumber, steel shod, or of a steel channel two feet longer than the proposed width of pavement slab and sufficiently strong and rigid to retain its shape under all working conditions. In making the strike-off above mentioned, the template shall be moved forward with a combined longitudinal and transverse shearing motion, moving always in the direction in which The Work is progressing and so manipulated that neither end is raised from the side forms during the strike-off process.

After the concrete has been consolidated, the surface shall be struck-off to the true section with a hand operated screed. This screed shall be mechanically vibrated at a rate not less than thirty-five hundred (3,500) vibrations per minute. The screed may be adjusted, or a separate screed shall be furnished, for each variation in crown section. This screed shall be operated forward with a combined longitudinal and transverse motion, and shall be so manipulated that neither end will be raised off the side forms. Not less than two screedings of the surface shall be made.

(8) Hand Method, Finishing. After the concrete has been placed, consolidated and struck-off as hereinbefore prescribed, the pavement shall be finished in the manner described as follows:

A float, twelve inches wide and twelve feet long with edges of its bottom surface rounded, shall be equipped with plow handles of such length that the operators may stand upright while working from bridges.

The float shall be operated longitudinally over the entire surface of the pavement and with a combined longitudinal and transverse motion, passing slowly from one side of the pavement to the other, a sufficient number of times (at least twice) to smooth all ridges and fill all depressions, until the float on its last passage shall show contact with the concrete throughout its entire length and width. The float shall rest flat on the surface of the concrete throughout this operation except that if a ridge be encountered which cannot be eliminated by floating, the float may be tilted so that its edge will operate as a screed to remove the excess concrete, after which the surface shall be refloated with the float in the flat position. Depressions appearing after the initial passage of the float shall be filled with additional concrete before the final passage. The float shall be operated by men working on bridges that span the full width of pavement. In moving forward with the float each successive position shall overlap the preceding position by one-half of the length of the float.

(9) Hand Method, Straightedge Finishing. Straightedge finishing by hand methods shall be performed in accordance with "Straightedge Finishing" in Part (L)(4) of this Article.

(10) Hand Method, Belting. Belting by hand methods shall be performed in accordance with "Belting" in Part (L)(5) of this Article.

(11) Hand Method, Final Finish, Burlap Drag. The final finish with burlap drag shall be performed in accordance with "Burlap Drag" in Part (L)(6) of this Article.

(12) Surface Test. After the concrete has hardened, the surface of the pavement shall be tested with a ten foot straightedge, operated parallel to the centerline of the pavement. During the test, each depression shall be successively spanned, each high spot touched by the testing edge, so as to reveal all irregularities. All portions of pavement showing a variation or departure from the testing edge of more than one-sixteenth (1/16) inch per foot of distance, from the nearest point of contact with the testing edge or showing a total variation in excess of one-eighth ($\frac{1}{8}$) inch from the ten foot straightedge, shall be corrected by grinding until the variations are within the above limits, provided, however, that where the methods used would result in an unsatisfactory surface, or where the grinding would result in a slab thickness less than specified or shown on the plan cross section, the affected portions of pavement shall be removed and replaced. All corrections of irregularities and removing and all replacing of pavement, shall be done at the contractor's expense. Any area of section to be removed and replaced shall be accomplished in accordance with "Deficient Thickness," as specified in Article 39.08(E).

(M) Protection and Curing. **(1) Membrane.** After the concrete has been finally finished and the free water has left the surface, the entire area of the pavement surface shall be sealed, by hand or machine spraying, using a uniform application of curing compound, specified in Article 39.02(O). The solution shall be applied in one or two separate applications as may be recommended by the manufacturer and as directed. If the solution is applied in two increments, the second application shall follow the first application within thirty minutes. The contractor shall provide satisfactory equipment and means to properly control and assure the direct application of the curing solution on the pavement surface so as to result in a uniform coverage in the pavement at the rate of one gallon for each one-hundred-and-fifty (150) square feet of area. Satisfactory equipment and means to control and apply the curing solution shall be construed as being whatever appliances and methods that are needed to prevent the loss of any of the solution during the application, together with an approved means of measuring the quantity to be applied and to insure complete and uniform coverage of the pavement.

If rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is dam-

aged in any other way, the contractor will be required to apply a new coat of material to the affected portions equal in curing value to that above specified. All areas cut by finishing tools subsequent to the application of the curing solution shall immediately be given new applications at the specified rate above.

The contractor shall provide, on the job, sufficient burlap for the protection of the pavement in case of rain or breakdown of the spray equipment. In the event that hair checking develops before the curing compound can be applied, the procedure shall be modified in that initial curing with wet burlap, cotton mats or other material, approved by the engineer, shall be performed before the curing compound is placed.

(2) Wet Burlap or Cotton Mats. Preliminary curing may be accomplished by covering the entire surface of the pavement with blankets of wetted burlap, cotton fabric or other material of highly absorptive quality, previously approved by the engineer, laid directly upon the finished surface as soon after final finishing as possible without marring the surface. The material shall be kept saturated in place for at least thirty hours.

For completion of the curing, the mats used for the preliminary curing period may be left in place and kept saturated for ninety-six hours or may be removed at the end of thirty hours, the preliminary period, and immediately sealed with the curing compound specified in Article 39.02(O).

39.05 OPENING TO TRAFFIC. Opening to traffic, including the contractor's vehicles, will not be permitted until the longitudinal joints have been completed and the compressive strength of 6" x 12" cylinders, tested in conformity with AASHO T 22, is at least four thousand (4,000) pounds per square inch.

If permanent shoulders are not in place, a temporary earth shoulder shall be placed against the outside pavement edges before traffic is allowed on the pavement.

Opening to all traffic shall not constitute a final acceptance of the pavement.

39.06 INTEGRAL CURB. Integral curb shall be the curb which is constructed monolithically with the pavement. Outside forms for the integral curb shall have a height not less than the specified height of the curb and shall conform to the requirements specified in Article 39.04(B) and Article 39.03(C). The inside face of the integral curb may be formed by approved steel forms held straight and rigid in place by steel clamps or space bars attached to the outside form.

The integral curb may be constructed by an alternate method, when approved by the engineer, which eliminates the use of an inside form. Sufficient additional concrete shall be placed against the outside form to construct the integral curb

along with the concrete placed for the pavement. The inside face of the curb shall be formed by means of a special steel template or "mule" shaped to the dimensions and cross section shown on the plans. The top edge of the integral curb shall be rounded with an edger to form the radii shown on the plans.

The inside face of the curb shall be finished true to the lines and grades shown on the plans and the finish shall be the same as specified for the concrete pavement including longitudinal floating and burlap drag finishing. While the concrete is still plastic, the surface shall be tested for longitudinal trueness with a straightedge and the surface shall meet the same surface requirements as specified for the concrete pavement.

Joints in the concrete pavement shall be continued through the integral curb at the same locations and shall be the same type of joint and constructed in the same manner as required for the concrete pavement.

The integral curb shall be cured in accordance with the requirements specified for concrete pavement.

Integral curb shall not be measured and paid for separately, but shall be included with and considered a part of the price bid and paid for concrete pavement.

39.07 WEATHER AND NIGHT LIMITATIONS. Except by specific written authorization, concreting operations shall not be continued when a descending air temperature in the shade and away from artificial heat falls below 40°F. nor resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F. In such cases the aggregates may be heated, either by steam or dry heat, prior to being placed in the mixer. The equipment used for heating the aggregates shall heat the mass uniformly and preclude the possible occurrence of overheated areas which might injure the materials. The temperature of the mixed concrete shall not be less than 50°F. or more than 70°F. at the time of placing it in the forms.

If the temperature during the ten hours previous to the placing of the concrete has been 32°F. or less, the aggregates and water shall be heated to not less than 70°F. nor more than 100°F. Material containing frost or lumps or hardened material shall not be used. Neither salt nor chemical admixtures shall be added to the concrete to prevent freezing.

Concreting operations shall be discontinued when darkness would prevent good workmanship in placing and finishing operations. Night operations may be conducted upon specific approval of the engineer and when an adequate and approved artificial lighting system is provided and operated.

When concrete is being placed during cold weather and the air temperature may be expected to drop below 35°F. a sufficient supply of straw, hay, grass or other suitable blanketing material shall be provided along the line of The Work and

at any time when the air temperature may be expected to reach the freezing point during the day or night the material so provided shall be spread over the pavement to a sufficient depth to prevent freezing of the concrete before it has thoroughly hardened. The period of time over which such protection shall be maintained shall be not less than ten days. If required by the engineer, concrete laid less than twenty-four hours shall be covered by approved canvas or similar heating enclosures and devices capable of maintaining the temperature within the concrete at not less than 50°F. The contractor shall be responsible for the quality and strength of the concrete laid during cold weather and any concrete injured by frost action shall be removed and replaced at his expense.

39.08 METHOD OF MEASUREMENT. (A) Portland cement concrete pavement shall be measured by area in square yards and the yardage to be paid for shall be the number of square yards of concrete pavement of the specified thickness, including integral curb, completed and accepted, measured in place. The width for measurement will be the width from outside to outside of completed pavement, but not to exceed the width as shown on the plans or as ordered by the engineer. The length will be the actual length measured along the centerline of the pavement surface. Area constructed other than as pavement will be deducted from the area of pavement.

(B) Fillets, for widened sections or at drainage structures and similar locations placed monolithic with the pavement, will be measured and included as pavement. No deduction will be made for any fixture located within the limits of the pavement when such fixture has a surface area, in the plane of the pavement surface, of nine square feet or less.

(C) Pavement will be measured to the nearest one-tenth square yard.

(D) It is the intent of the specifications that pavement shall be constructed strictly in accordance with the thickness shown on the plans. The thickness of the pavement shall be measured, and where any pavement is found not so constructed, such pavement may be compensated for at an adjusted unit price per square yard, or such pavement may be removed and replaced with satisfactory pavement.

(E) **Deficient Thickness.** If so ordered, pavement thickness may be determined by at least two cores taken from each one-thousand (1,000) linear feet of each lane and at such other locations as the engineer may direct. Payment will not be made for slabs deficient in thickness by more than one-half ($\frac{1}{2}$) inch. If so ordered, such slabs shall be removed and replaced at the expense of the contractor with concrete of required thickness which, when accepted, shall be included in the pay

yardage. Deductions for deficiency in thickness are herewith tabulated:

Deficiency in Thickness	Proportional Part of Contract Price Allowed
$\frac{1}{8}$ in. to $\frac{1}{4}$ in.	90%
$\frac{1}{4}$ in. to $\frac{1}{2}$ in.	75%

In removing pavement that is deficient in thickness, the pavement shall be removed from the edge to a longitudinal joint, or between longitudinal joints and on each side of the deficient measurement until no portion of the exposed cross section is more than one-eighth inch deficient, except that in no instance shall there be less than ten linear feet of pavement removed. If, in meeting the above requirements, there remains less than five feet of acceptable pavement between the section that has been removed and a transverse plane of weakness (contraction, expansion or construction joints), then the contractor shall remove the pavement to the plane of weakness. The contractor shall then replace with satisfactory pavement all of the pavement that has been removed. Deductions for deficient thickness may be entered on any estimate after the information becomes available.

(F) Material used as a foundation course for the concrete pavement shall be measured in accordance with the item as bid and with the provisions of the section pertaining to that material.

39.09 BASIS OF PAYMENT. The yardage of completed and accepted Portland cement concrete pavement, measured as provided for above, with no additional compensation for any excess thickness, shall be paid for at the contract unit price per square yard, for "Concrete Pavement" with proper allowance made for any deductions for deficiency in thickness, which price shall be full compensation for furnishing, hauling, preparing, placing, finishing, curing and protecting, and for all materials, joints and joint materials, dowels, tie bars, and spacer bars, and for all integral curb and for preparing the subgrade and foundation course, and for all other operations necessary to complete The Work.

Material used as a foundation course shall be paid for as indicated in the proposal form and in accordance with the applicable section.

SECTION 41

CONCRETE BRIDGES

SUBSECTION 41.00 CONCRETE STRUCTURES.

41.01 DESCRIPTION. Work and materials under this section shall consist of concrete bridges and the concrete portions of steel, timber and composite bridges, constructed in conformity with the plans or as ordered in writing by the engineer, and in accordance with this and other specification items involved.

41.02 FIELD OFFICE. Unless specified otherwise, the contractor shall provide a field office, for the engineer, in accordance with the provisions of Article 05.08.

41.03 MATERIALS. All materials used shall be those prescribed for the several items which constitute the structure.

41.04 CONSTRUCTION METHODS. **(A) Foundations.** All foundations shall be prepared as specified under Section 45 and they shall be inspected and approved by the engineer previous to placing any concrete.

(B) Drains. Drains and waterstops shall be constructed as shown on plans or as directed by the engineer.

(C) Placing Concrete. Concrete shall be placed in accordance with Section 46.

(D) Falsework and Centering. Unless otherwise provided, detailed plans for falsework or centering shall be supplied to the engineer upon request, but in no case shall the contractor be relieved of responsibility for results obtained by the use of these plans.

Arch centering shall be constructed according to centering plans approved by the engineer. Provision shall be made by means of suitable wedges or jacks for the gradual adjustment and release of falsework or centering supports. Supplemental sand boxes or other approved devices may be used for lowering arch centering.

No falsework or centering supports shall be removed unless removal meets with approval of the engineer. In general, falsework or centers shall be struck before coping or railing forms are erected. This precaution is essential in multiple spans to avoid joining of expansion joints and to provide for variations in alignment and camber. For filled spandrel arches, such portions of the spandrel walls shall be left for construction subsequent to the striking of centers as may be necessary to avoid jamming of the expansion joints.

Falsework or centers shall be gradually and uniformly lowered in such a manner as to avoid stresses in any part of the structure. In structures of two or more spans, the sequence of striking falsework or centers shall be specified or approved by the engineer.

41.05 METHOD OF MEASUREMENT. The quantities of the various items which constitute the completed and accepted structure shall be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing.

41.06 BASIS OF PAYMENT. The measured quantities as provided above shall be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for furnishing, hauling, and placing all materials, and for labor, equipment, tools, drains, water stops and necessary incidentals. Such payment shall constitute full compensation for the completed structure, ready for use, and no additional allowance will be made for cofferdam construction, falsework, form lumber, or other erection expenses unless otherwise set forth on the plans or in the special provisions.

SUBSECTION 41.10 PRECAST PRESTRESSED CONCRETE BEAMS

41.10 DESCRIPTION. Materials and work under this subsection shall consist of precast prestressed concrete beams constructed, delivered, and erected in place in accordance with these specifications and the plans, or as modified in writing or by special provisions. Design shall be in accordance with AASHO Standard Specifications for Highway Bridges as amended and supplemented, including T.1(58) Div. I, Sect. 13—Prestressed Concrete.

41.11 LIVE LOAD. H20-S16(44) or alternate loading for bridges and floor systems with spans under 40 ft.; two axles four feet apart with each axle weighing 24,000 lbs.; for 24-foot, 28-foot, 38-foot and 44-foot roadways.

H15-S12 loading for 24-foot roadways.

41.12 FABRICATION DRAWINGS. The fabrication drawings shall consist of fabrication details, erection and other working plans showing details, dimension and other information and data necessary for the complete fabrication and erection of the precast, prestressed concrete beams, including the method and sequence of stressing. Approval of fabrication drawings by the engineer shall be secured before fabrication of beam is commenced. The contractor shall furnish the engineer with prints of the fabrication drawings, in quadruplicate, for approval, and after approval he shall furnish three or more prints, as required, of the approved drawings. All fabrication drawings shall be 22" x 36" with a 1½" margin on the left side and a ½" margin on the other three sides. No deviation from the approved plans shall be permitted without a written order from the engineer.

41.13 MATERIALS. (A) Prestressed Concrete. All prestressed concrete shall have the fine aggregate, coarse aggregate, cement and water ratios properly proportioned by the

engineer so as to attain a minimum compressive strength of 5,000 p.s.i. at the age of 28 days. The minimum compressive strength of the concrete at the transfer of prestress shall be 4,000 p.s.i. except as otherwise shown on precast, prestressed concrete beam standard drawings. The design mix shall be based on tests with the materials to be used in the construction, with specimens made and tested in accordance with AASHO methods T 22 and T 126.

The maximum size of aggregate shall be $\frac{3}{4}$ inch.

All cement shall be low-alkalai Portland Cement of Type I, Type II or Type III, but only one type of cement shall be used for the precast prestressed beams for any one structure or adjacent structures.

Subject to the approval of the engineer, an admixture for water reduction in concrete in obtaining increased compressive strength may be used. The admixture, if used, shall be water-reducing for obtaining increased compressive strength and shall be free of calcium chloride. It shall reduce the water content of the concrete at least 5 percent when compared with a similar mix without the admixture. When used in the amount required to obtain the desired water reduction, it shall not retard the set of the concrete by more than 40 percent when tested by ASTM Method C 403. Concrete that contains the water-reducing admixture shall be equal in compressive strength at 3 days, and at least 10 percent greater at 28 days, than a similar concrete mix of the content and consistency. Tests to determine compliance of a water-reducing admixture with these requirements for strength shall be made with job materials in accordance with AASHO Methods T 126 and T 22.

An air entraining agent may be added to prestressed concrete, when approved by the engineer.

(B) Cast-In-Place Concrete. All cast-in-place concrete shall be Class "AD" having a minimum compressive strength of 3,000 p.s.i. at the age of 28 days.

All cement for cast-in-place concrete shall be Type II.

An air entraining agent shall be added to all cast-in-place concrete.

(C) Mild Steel Reinforcement. All reinforcing steel shall be of deformed bars of intermediate grade billet steel conforming to ASTM A 15. Deformations shall conform to ASTM A 305, except as otherwise noted.

(D) Structural Steel. All structural steel for the end anchorages of the post tensioned beams, bearing devices, and expansion dams shall conform to ASTM A 7.

(E) Prestressing Reinforcement. Prestressing reinforcement shall be high-tensile-strength steel wire, high-tensile-strength seven-wire strand or high-tensile-strength alloy bars as called for on the plans or in the special provisions.

High-tensile-strength steel wire shall be made by the open-hearth or electric-furnace process. The wire shall be cold drawn to size and suitably stress-relieved after cold drawing by a continuous strand heat treatment to produce the prescribed physical properties. There shall be no welds or joints in the finished wire.

Tensile strength shall conform to the following requirements:

Nominal wire diameter— <u>inches</u>	0.192	0.196	0.250	0.276
Minimum Tensile Strength— <u>p.s.i.</u>	250M	250M	240M	235M

The minimum yield strength for all wire, measured by the 1.0 percent-extension-under-load method, shall not be less than 80 percent of the specified minimum breaking strength. The total elongation under load of all wire shall not be less than four percent when measured in a gage length of 10 inches. The diameter of the wire shall not vary from the nominal diameter specified by more than plus or minus 0.002 inch, nor to be out of round by more than 0.002 inch. High-tensile-strength seven-wire strand shall conform to ASTM A 416.

High-tensile-strength alloy bars shall be stress relieved and then cold stretched to a minimum of 130,000 p.s.i. After cold stretching, the physical properties shall be as follows:

Minimum ultimate tensile strength	145,000 p.s.i.
Minimum yield strength, measured by the 0.7 percent-extension-under-load method shall be not less than	130,000 p.s.i.
Minimum modules of elasticity	25,000,000
Minimum elongation in 20-bar diameters after rupture	4 percent
Diameter tolerance	+0.03" to -0.01"

(F) Pretensioning Steel. Except as otherwise approved, individual tendons in all pretensioned sections shall consist of 7-wire strands which have a nominal diameter of 7/16 inch and a minimum ultimate strength of 250,000 p.s.i. An initial tensile force of 18,900 lbs. shall be applied to each strand in all beams.

(G) Post Tensioning Steel. Before any materials are ordered or any work started, the contractor shall submit fabrication drawings as set forth in Article 41.12. Such drawings shall outline the method and sequence of stressing, complete specifications and details of the prestressing steel and anchorage devices, anchoring stresses, type of enclosures, and all other data pertaining to the prestressing operations. The total relaxed post tensioned forces which are required for the various beams are given in tabular form on the applicable Standard Drawings. These relaxed forces shall be obtained by applying initial tensile forces of sufficient magnitude to allow for all substantial losses, including those for creep, shrinkage, elastic deformation, friction and efficiency of end anchorages.

(H) Conduit. The conduit used to protect the prestressing reinforcement during pouring of the concrete in the post

tensioned beams shall be metallic, and completely mortartight so that mortar cannot enter the conduit which would later hinder the free movement of the prestressing reinforcement during the stressing operations. The conduit shall be strong enough to maintain its shape under such forces as will come upon it during handling, and during placing and vibration of the concrete. It shall have an inside diameter $\frac{1}{4}$ inch greater than the diameter of the bar, group of wires, or strand which it encloses. Rubber sheaths may be used in lieu of metallic conduit provided they are completely removed prior to any grouting of the prestressing reinforcement, and provided that they fulfill the other requirements specified herein.

(I) Grout for Conduits. Grout used for filling conduits in the post tensioned prestressed beams shall be mixed to the consistency of thick paint and in the following proportions:

1 part Portland Cement
 $\frac{3}{4}$ part (maximum) sand passing a No. 30 sieve
 $\frac{3}{4}$ part (maximum) water, by volume

Aluminum powder shall be added to the grout as follows:

From 2 to 4 grams of the powder (about 1 or 2 teaspoonful) shall be added for each sack of cement used in the grout.

The exact amount of aluminum powder shall be designated by the engineer. The distribution per batch of mortar shall be carefully weighed. A number of weighings may be made in the laboratory and doses placed in glass vials for convenient use in the mix. Batches of grout shall be made small enough so that the batch may all be used up in less than 45 minutes, as the action of the aluminum becomes very weak after this period of time. The aluminum powder shall be blended with pumicite or other inert powder in the proportion of one part aluminum to 50 parts pumicite (or other inert powder) by weight. The blend shall be thoroughly mixed with the cement and sand before water is added to the batch, as it has a tendency to float in the water. The amount of the blend used should vary from 4.5 ounces per sack of cement for concrete having a temperature of 70°F. to 7 ounces for concrete having a temperature of 40°F. The aluminum powder shall be of the unpolished variety. After all the ingredients are added, the batch shall be mixed for three minutes.

(J) Grout Tubes. Any grout tubes used for grouting the conduits in the post tensioned prestressed beams shall be of good grade commercial black or galvanized iron pipe.

(K) Testing Prestressing Reinforcement and Anchorage. All wire, strand, or bars to be shipped to the site shall be assigned a lot number and tagged for identification purpose. Anchorage assemblies to be shipped shall be likewise identified.

All samples submitted shall be representative of the lot to be furnished and, in the case of wire or strand, shall be taken from the same master roll. All of the materials specified for testing shall be furnished free of cost and shall be delivered in

time for tests to be made well in advance of anticipated time of use. Where the engineer intends to require nondestructive testing of one or more parts of the structure, special specifications shall be drawn giving the required details of the work.

The vendor shall furnish for testing the following samples selected from each lot. If ordered by the engineer, the selection of samples shall be made at the manufacturer's plant by the inspector.

Pretensioning method—For pretensioned strands, samples at least 7 feet long shall be furnished of each strand size. A sample shall be taken from each end of every coil.

Post-tensioning method—The following lengths shall be furnished:

For wires requiring heading—5 feet.

For wires not requiring heading—Sufficient length to make up one parallel-lay cable 5 feet long consisting of the same number of wires as the cable to be furnished.

For strand to be furnished with fittings—5 feet between near ends of fittings.

For bars to be furnished with threaded ends and nuts—5 feet between threads at ends.

Anchorage assemblies—Two anchorage assemblies shall be furnished, complete with distribution plates of each size or type to be used, if anchorage assemblies are not attached to reinforcement samples.

(L) Inspection. An inspector representing the engineer shall have free entry, at all times while the work on the contract is being performed, to all parts of the manufacturer's works which concern the manufacture of the materials ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with the plans and specifications.

(M) Rejection. Material which shows injurious defects during or previous to its installation in the structure shall be rejected.

41.14 CONSTRUCTION METHODS. **(A) General.** Unless otherwise approved by the engineer, the contractor shall certify to the engineer that a technician skilled in the prestressing method to be used will be available to the contractor to give as much aid and instruction in the use of the prestressing equipment and installation of materials as may be necessary to obtain satisfactory results.

Deviations from approved prestressing details will not be permitted unless details of such deviations are submitted, in advance of use, for approval by the engineer. The approval on the part of the engineer of any proposed method, materials or equipment shall not be construed as relieving the contractor, in any respect, of full responsibility for satisfactorily com-

pleting the prestressing operations in accordance with the requirements of the plans and these Specifications.

Safety measures must be taken by the contractor to prevent accidents due to possible breaking of the prestressing steel or the slipping of the grips during the prestressing process.

(B) Precast Prestressed Beams. Forms for the precast prestressed beams shall be of substantial construction. The cross sectional dimensions of the finished beams shall be those shown on the respective Standard Drawings. In order to allow for the elastic shortening of the prestressed beams and for normal concrete shrinkage, the overall lengths of the beams, at time of casting, shall be increased by the amount shown on the plans.

All prestressing steel shall be protected at all times from corrosion or damage. Before being placed in the conduits or stretched between abutments in a pretensioning bed, the steel shall be carefully cleaned of all rust, dirt, grease, oil or other foreign matter. The placing of all reinforcement, enclosures, prestressing steel, grout tubes, conduits, end anchorages, lifting eyes, etc., shall be inspected by the engineer and approved by him before any concrete is placed in the forms. If the prestressing system requires end anchorage plates, or if the end anchorages themselves provide sufficient bearing area, these plates or anchorages shall be in place and securely fastened so that the plane of the plate or end anchorage is exactly normal to the axis of the prestressing steel, and the concrete shall be poured directly against the bearing faces. Any recesses required to suit the prestressing materials shall be formed at the ends of the beams and filled with mortar after prestressing and anchoring has been accomplished. Prestressing steel and any enclosures used shall be securely held in position by spacer rods, wires, ties, etc. No deviation, horizontally or vertically, from the position shown on the plans or approved by the engineer greater than $\frac{1}{8}$ inch will be allowed.

Concrete shall not be deposited in the forms until the engineer has inspected the placing of all reinforcement and prestressing materials, lifting eyes, bolts, dowels, pipes, etc., and given his approval thereof. The concrete shall be vibrated using both internal and external vibrators, if required, to secure thorough compaction of the concrete. The vibrating shall be performed with care and in such manner as to avoid displacement of reinforcing, prestressing steel, lifting eyes, dowels, pipes, or any other items embedded in the concrete.

Steam curing of precast prestressed beams will be permitted in lieu of water curing as set forth in Article 46.05(K). Membrane curing will not be permitted. If the contractor elects to cure with steam, it shall be done under a suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam shall be from two to four hours after the final placement of

concrete to allow the initial set of the concrete to take place. If retarders are used, the waiting period before application of the steam shall be increased from four to six hours. The steam shall be at 100 percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. Application of the steam shall not be directly on the concrete. During application of the steam, the ambient air temperature shall increase at a rate not to exceed 40° F. per hour until a maximum temperature of from 140° F. to 160° F. is reached. The maximum temperature shall be held until the concrete has reached the desired strength. In discontinuing the steam, the ambient air temperature shall not decrease at a rate to exceed 40° F. per hour until a temperature has been reached about 20° F. above the temperature of the air to which the concrete will be exposed. The concrete shall not be exposed to temperature below freezing for six days after casting. If curing is to be by any other method, the method and its details shall meet with the approval of the engineer. Curing shall be continued until the design strength for the application of the prestress force (4,000 p.s.i. or 4,500 p.s.i. as the case may be) is reached, and care shall be taken to prevent drying until the design strength of 5,000 p.s.i. is reached.

The finish surfaces of the precast prestressed beams shall comply with the requirements of ordinary finish as set forth in Article 46.05(M).

(C) Prestressing. The prestressed beams shall be prestressed after the concrete has attained a minimum strength of 4,000 p.s.i. except as otherwise shown on precast prestressed concrete beam standard drawings, as determined by cylinder tests. The wires, strands, bars, or cable shall be accurately held in position and stressed by hydraulic jacks. If pretensioned prestressed beams are constructed, several units may be formed, end-to-end, and the strands stressed at one time. In this case, sufficient space must be left between the ends of adjacent units to permit access to the steel for cutting after the concrete has attained the required strength. Pretensioned strands shall be released and post tensioned bars or cables shall be stressed in such order that lateral eccentricity of the prestressing force will be a minimum.

Jacks shall be equipped with accurate reading, calibrated hydraulic pressure gauges to permit the stress in the prestressing steel to be computed at any time. A certified calibration curve shall accompany each jack. All special equipment, jacks, or other devices that may be required for performing the prestressing operations in a satisfactory manner shall be furnished by the contractor. The engineer may require a check of the calibration or recalibration of any jack during the prestressing operations. All costs for such testing or recalibration shall be borne by the contractor.

The design data and the final required prestressed forces given on the plans or approved by the engineer shall be used to determine the required initial prestressing forces. These initial prestressing forces, further adjusted if necessary for any losses due to friction, take-up in end anchorages, etc., shall be jacked into the prestressing units. Accurate measurements of the elongation of the prestressing reinforcement shall be taken and used to check the prestressing force indicated from the jack gauge readings. A record shall be kept of the jacking force and the elongations produced thereby and a copy thereof shall be furnished the engineer. Simultaneous jacking from both ends of the prestressed beams may be required. Means shall be provided for measuring the elongation to an accuracy of 0.045 inches for each 100 ft. of length between jacking heads. In the event of apparent discrepancies, between gauge pressure and elongation, of more than 5%, the entire operation shall be carefully checked and the source of error determined before proceeding further.

An approved tensiometer shall be available at the fabricating plant at all times for the engineer's use in determining the actual stress in the various segments of the deflected strands.

(D) Grout. After completion of the post tensioning operations, all conduits shall be first flushed out with water and then blown out with air. If a rubber sheath has been used as the enclosure, it shall be completely removed and the void treated as described above. The conduit or void shall then be entirely filled with the specified grout under a pressure of not to exceed 100 p.s.i. This grouting operation shall be continued until a steady flow of the grout is emitted from the pipe opening at the other end of the conduit being grouted. This opening shall then be closed while the grout is under pressure, and finally the grouting tube connection closed. The final pressure placed on the grout shall be 50 to 100 p.s.i.

(E) Storing, Hoisting and Handling. Care shall be taken during the storage, hoisting and handling of the precast beams to prevent cracking or damage. Members damaged by improper storing or handling shall be replaced by the contractor at his own expense. No prestressed concrete beam shall be moved from the location at which it was cast until the beam has been prestressed. The beam shall be maintained in a vertical position during any handling or while being transported. During storage, or transportation, the beam shall be supported by cross timbers located near the ends of the beams and directly under the lifting eyes. Lifting of the beams shall be done only by use of the lifting eyes. During lifting of the beams, spreaders shall be used between the slings to eliminate the horizontal component of the lifting force applied to the beams.

41.15 METHOD OF MEASUREMENT. The quantity to be paid for shall be the actual number of units of precast pre-

stressed beams of the different lengths required, precast, prestressed, erected complete in place, and accepted. Each beam of the different lengths required shall constitute a unit, and shall include all prestressing reinforcement, conduit, end anchorage, mild steel reinforcement, $\frac{3}{4}$ " coil loops, bearing plates, rockers, base plates, lifting eyes, embedded pipes, grout, bolts, etc., and any other materials called for on the plans.

41.16 BASIS OF PAYMENT. The precast prestressed beams shall be paid for at the unit price bid per beam, determined as provided above, complete in place, which price and payment shall constitute full compensation for furnishing all materials, precasting, prestressing, transportation, and erecting complete in place, and for all labor, equipment, tools and incidentals necessary to complete the item.

SECTION 42

STEEL BRIDGES

42.01 DESCRIPTION. Work and materials under this section shall consist of steel bridges, including but not limited to superstructures to be placed on concrete, masonry, steel or timber substructures, constructed in conformity with the plans or as ordered in writing, and in accordance with this and other specification items involved.

42.02 FIELD OFFICE. Unless specified otherwise, the contractor shall provide a field office, for the engineer, in accordance with the provisions of Article 05.08.

42.03 MATERIALS. All materials used shall be those prescribed for the several items which constitute the structure.

42.04 FOUNDATIONS. All excavation for foundations and substructures shall be performed as specified under Section 45.

42.05 PLACING CONCRETE. All concrete shall be placed and finished in accordance with Section 46.

42.06 FABRICATION. Structural steel shall be fabricated in accordance with the following requirements:

(A) **Drawings.** The construction plans shall consist of shop details, erection and other working plans showing details, dimensions, size of material and other information and data necessary for the complete fabrication and erection of the metal work. Approval of construction plans by the engineer shall be secured before fabrication of steel work is commenced. The contractor shall furnish the engineer with prints of the shop drawings, in quadruplicate, for approval, and after approval he shall furnish three or more prints, as required, of the approved drawings. All shop drawings shall be 22" x 36" with a 1½" margin on the left side and a ½" margin on the other three sides. Upon completion of The Work the original tracings, if required, shall be supplied to the engineer. No deviation from the approved plans shall be permitted without a written order from the engineer. Changes on approved drawings shall be subject to the approval of the engineer, and he shall be supplied with a record of such changes. Substitutions of sections different from those shown on the drawings shall be made only when approved in writing.

(B) **Workmanship and Finish.** The workmanship and finish shall be equal to the best practice in modern bridge shops. Shearing, flame cutting and chipping shall be neatly and accurately done and all portions of the work exposed to view shall be neatly finished.

(C) **Storage of Materials.** Structural material, either plain or fabricated, shall be stored at the bridge site above the ground upon platforms, skids, or other supports. It shall be kept free

from dirt, grease or other foreign matter, and shall be protected as far as practicable from corrosion.

(D) Straightening Materials. Rolled material before being laid out or worked must be straight. If straightening is necessary, it shall be done by methods that will not injure the metal. Sharp kinks and bends may be cause for rejection of the material.

(E) Punched Work. If general reaming is not required, all material, forming parts of a member composed of not more than five thicknesses of metal, may be punched $\frac{1}{16}$ inch larger than the nominal diameter of the rivets whenever the thickness of the metal is not greater than $\frac{3}{4}$ inch for carbon steel or $\frac{5}{8}$ inch for alloy steel.

When there are more than five thicknesses or when any of the main material is thicker than $\frac{3}{4}$ inch in carbon steel, or $\frac{5}{8}$ inch in alloy steel, all the holes shall be subpunched or subdrilled $\frac{3}{16}$ inch smaller and, after assembling, reamed $\frac{1}{16}$ inch larger, or drilled from the solid to $\frac{1}{16}$ inch larger, than the nominal diameter of the rivets.

(F) Punched Holes. Holes punched full-size shall be $\frac{1}{16}$ inch larger than the nominal diameter of the rivet. The diameter of the die shall not exceed the diameter of the punch by more than $\frac{1}{16}$ inch. If any holes must be enlarged to admit the rivets, they shall be reamed. Holes must be clean cut, without torn or ragged edges. Poor matching of holes will be cause for rejection.

(G) Accuracy of Punched and Subdrilled Holes. All holes punched full-size, subpunched, or subdrilled shall be so accurately punched that after assembling (before any reaming is done) a cylindrical pin $\frac{1}{8}$ inch smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75 percent of the contiguous holes in the same plane. If the requirement is not fulfilled, the badly punched pieces will be rejected. If any hole will not pass a pin $\frac{3}{16}$ inch smaller in diameter than the nominal size of the punched hole, this will be cause for rejection.

(H) Reamed or Drilled Holes. Reamed holes shall be cylindrical, perpendicular to the member and not more than $\frac{1}{16}$ inch larger than the nominal diameter of the rivets. Where practicable, reamers shall be directed by mechanical means. Drilled holes shall be $\frac{1}{16}$ inch larger than the nominal diameter of the rivet. Burrs on the outside surfaces shall be removed. Poor matching of holes will be cause for rejection. Reaming and drilling shall be done with twist drills. If required by the engineer, assembled parts shall be taken apart for removal of burrs caused by drilling. Connecting parts requiring reamed or drilled holes shall be assembled and securely held while being reamed or drilled and shall be match-marked before disassembling.

(I) Subpunching, Reaming and Shop Assembly. Unless otherwise specified, holes in all field connections and field splices of main truss or arch members, continuous beams, plate girders and rigid frames shall be subpunched (or subdrilled if subdrilling is required), and reamed while assembled in the shop. The assembly, including camber, alignment, accuracy of holes and milled joints, shall be approved by the engineer before reaming is commenced. Unless otherwise authorized, each individual (full length) truss, arch, continuous beam or girder shall be assembled in the shop before reaming is commenced. All holes for floor beam and stringer field end connections shall be subpunched and reamed to a steel template or reamed while assembled. If additional subpunching and reaming is required, it shall be specified in the special provisions or on the plans.

(J) Accuracy of Reamed and Drilled Holes. When holes are reamed or drilled, 85 percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/32-inch between adjacent thickness of metal.

(K) Shop Assembling. Shop assembly of trusses, arches, continuous beam spans and plate girders shall be according to Part (I) above.

Complete shop assembly of an entire structure, including floor systems, which may be necessary in the case of complicated designs shall be done when shown on the plans or when stipulated in the special provisions. Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before reaming or riveting is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation. The member shall be free from twists, bends, and other deformation. Preparatory to the shop riveting of full-sized punched material, the rivet holes, if necessary, shall be spear-reamed for the admission of the rivets. The reamed holes shall not be more than 1/16 inch larger than the nominal diameter of the rivets. End connection angles, stiffener angles, and similar parts shall be carefully adjusted to correct positions and bolted, clamped, or otherwise firmly held in place until riveted. Parts not completely riveted in the shop shall be secured by bolts, insofar as practicable, to prevent damage in shipment and handling.

Expansion devices for bridges shall be assembled in the shop sufficiently to determine that a proper fit between the various component parts of each joint has been achieved.

(L) Camber Diagram. A camber diagram shall be furnished the engineer, showing the camber at each panel point for each truss, taken from actual measurements while the truss is assembled.

(M) Drifting of Holes. The drifting done during assembling shall only be such as to bring the parts into position, and

not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the rivets, they shall be reamed.

(N) Match-Marking. Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match-marked, and a diagram showing such marks shall be furnished to the engineer.

(O) Rivets. The size of rivets called for on the plans shall be the size before heating. Rivet heads shall be of standard shape, unless otherwise specified, and of uniform size for the same diameter of rivet. They shall be full, neatly made, concentric with the rivet holes, and in full contact with the surface of the member.

(P) Field Rivets. Field rivets shall be furnished in excess of the nominal number required to the amount of 10 percent plus 10 rivets for each diameter and length.

(Q) Bolts and Bolted Connections. **(1) General.** Bolted connections shall not be used unless shown on the plans. Where bolted connections are permitted, the bolts furnished shall be unfinished bolts (ordinarily rough or machine bolts) unless otherwise specified. Turned bolts shall be provided where shown on the plans, or if required by the special provisions. Special ribbed drive fit bolts may be substituted for turned bolts upon written approval of the engineer. Bolted connections fabricated with high tensile strength bolts shall conform to Part (R) of this Article.

The holes shall be truly cylindrical. The size of holes shall be 1/16 inch greater than the nominal diameter of the bolts and shall make a driving fit with the bolts. Holes shall be at right angles to the surface of the metal so that both head and nut will bear squarely against the metal. Bolts shall be driven accurately into the holes without damaging the thread. A snap shall be used to prevent damaging the heads.

The heads and nuts shall be drawn tight against the work with a suitable wrench not less than 15 inches long. Bolt heads shall be tapped with a hammer while nut is being tightened. Where bolts are to be used in beveled surfaces, beveled washers shall be provided to give full bearing to the head or nut. All bolts shall have cut threads neatly and accurately finished. The nuts of unfinished, turned bolts and ribbed bolts shall be effectually locked after they have been finally tightened.

(2) Unfinished Bolts. Unfinished bolts shall be standard bolts with hexagonal heads and nuts. The diameter of the bolt holes shall be 1/16 inch greater than the diameter of the bolts used. Bolts transmitting shear shall be threaded to such a length that not more than one thread will be within the grip of the metal. The bolts shall be of such length that they will extend entirely through their nuts, but not more than $\frac{1}{4}$ inch beyond them. The number of bolts furnished shall be 5 percent more than the actual number shown on the plans for each size and length.

(3) Turned Bolts. Holes for turned bolts shall be carefully reamed and the bolts turned to a driving fit with the threads entirely outside of the holes and a washer shall be used. The heads and nuts shall be hexagonal. Turned bolts shall be finished by a finishing cut.

(4) Special Ribbed Bolts. Ribbed bolts, with drive fit, shall be used only where called for on the plans or approved in writing by the engineer. Ribbed bolts may be substituted for field rivets in locations where, in the opinion of the engineer, it is impractical to drive rivets. Ribbed bolts shall be furnished in the same number and in nominal sizes not smaller than the rivets for which they are substituted. They shall be furnished in sufficient variety of lengths that when drawn tight the fluted shank will fill the hole in the work and the thread will completely fill the nut with not more than one thread protruding. If for any reason the bolts twist before drawing tight, the holes shall be carefully reamed and the bolt replaced with a new bolt of diameter to fit properly in the hole. The contractor shall provide and supply himself, at his sole expense, with oversize bolts for this replacement in an amount not less than 10 percent of the number of ribbed bolts specified.

(R) Connections Using High Tensile Strength Bolts. **(1) General.** This specification covers the assembly of structural joints using ASTM A 325 high strength steel bolts tightened to a high tension. The bolts are used in holes slightly larger than the nominal bolt size.

Construction shall conform to the applicable specification for riveted or welded structures of wrought iron, carbon structural steel and high strength steel, except as otherwise provided herein.

(2) Bolts, Nuts and Washers. Bolts, nuts and washers shall conform to ASTM A 325, the specification for Quenched and Tempered Steel Bolts and Studs with Suitable Nuts and Plain Hardened Washers, except as hereinafter provided.

Bolt dimensions shall conform to ASA B 18.2, regular semi-finished hexagon bolts, except as hereinafter provided. Alternatively, bolts may be furnished meeting one of the following descriptions:

(a) Hexagon head having same height as regular semi-finished hexagon bolt but having width across flats equal to corresponding heavy semi-finished hexagon bolt.

(b) Interference-body bolts, with heads conforming to ASA B 18.4 for driven button heads for large rivets of the same nominal diameter, except that the head may be flattened to the same height as the head of the regular semi-finished hexagon bolt. Interference-body bolts are not to be used in other than ASTM A 7 and A 373 steels.

Nut dimensions shall conform to ASA B 18.2, heavy semi-finished hexagon nuts. Alternatively, finished hexagon nuts,

conforming to ASA B 18.2 and ASTM A 194, Grade 2H, may be used instead of heavy semi-finished hexagon nuts.

Circular washers shall be flat and smooth and their nominal dimensions shall be not less than those given in Table 1 of this article with ASA B 27.2. Type A washer tolerances applied to these nominal dimensions. Beveled washers shall be square or rectangular, taper in thickness, and conform to the dimensions given in Table 1.

Where necessary, washers may be clipped on one side to a point not closer than $\frac{7}{8}$ of the bolt diameter from the center of the washer.

TABLE 1 — WASHER DIMENSIONS (inches)

Bolt Size	Circular Washers				Square or Rectangular Washers for American Standard Beams and Channels		
	Inside Diameter*	Minimum Outside Diameter	Nom. Thick. Gage No.	Nom. Thick.	Width Minimum	Mean Thickness	Slope or Taper in Thickness
$\frac{1}{2}$	9/16	1 $\frac{3}{8}$	12	0.109	1 $\frac{3}{4}$	5/16	1:6
$\frac{5}{8}$	11/16	1 $\frac{1}{2}$	10	0.134	1 $\frac{3}{4}$	5/16	1:6
$\frac{3}{4}$	13/16	1 $\frac{3}{4}$	9	0.148	1 $\frac{3}{4}$	5/16	1:6
$\frac{7}{8}$	15/16	2	8	0.165	1 $\frac{3}{4}$	5/16	1:6
1	1 1/16	2		0.165	1 $\frac{3}{4}$	5/16	1:6
1 $\frac{1}{8}$	1 1/4	2 $\frac{1}{2}$	8	0.165	2 $\frac{1}{4}$	5/16	1:6
1 $\frac{1}{4}$	1 3/8	2 $\frac{3}{4}$	8	0.165	2 $\frac{1}{4}$	5/16	1:6
1 $\frac{1}{8}$	1 1/2	3	7	0.180	2 $\frac{1}{4}$	5/16	1:6
1 $\frac{1}{2}$	1 5/8	3 $\frac{1}{4}$	7	0.180	2 $\frac{1}{4}$	5/16	1:6

* Not to be increased if larger washers are used.

(3) Bolted Parts. Surfaces of bolted parts in contact with the bolt head and nut shall not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material. Holes may be punched, sub-punched and reamed, or drilled, as required by the applicable specification and shall be of a nominal diameter not more than 1/16 inch in excess of the nominal bolt diameter.

When assembled, all joint surfaces, including those adjacent to the washers, shall be free of scale except tight mill scale. They shall be free of dirt, loose scale, burrs, and other defects that would prevent solid seating of the parts.

Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.

(4) Installation. Bolts shall be installed with a hardened washer under the nut or bolt head, whichever is the element turned in tightening. A hardened washer shall also be used under the head of regular semi-finished hexagon bolts and under finished hexagon nuts, even when these are not the elements turned in tightening. The washer may be omitted under the head of heavy semi-finished hexagon bolts and interference-body bolts, and under heavy semi-finished hexagon nuts, when these are not the elements turned. A flat washer may be used when the abutment surface adjacent to the bolt head or nut does not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for lack of parallelism.

All fasteners shall be tightened to give at least the required minimum bolt tension values shown in Table 2 on completion of the joint. Tightening shall be done with properly calibrated wrenches.

TABLE 2 — BOLT TENSION

Bolt Size inch	Required Minimum Bolt Tension-lbs.*	Bolt Size inch	Required Minimum Bolt Tension-lbs.*
½	12,050	1	47,250
5/8	19,200	1 1/8	56,450
¾	28,400	1 ¼	71,700
7/8	36,050	1 3/8	85,450
		1 ½	103,950

* Equal to the proof load of bolt given in ASTM A 325.

When calibrated wrenches are used to provide the bolt tension specified in Table 2, their setting shall be such as to induce a bolt tension slightly in excess of this value. These wrenches shall be calibrated by tightening, in a device capable of indicating actual bolt tension, not less than three typical bolts from the lot to be installed. Power wrenches shall be adjusted to stall or cut-out at the selected tension. If manual torque wrenches are used, the torque indication corresponding to the calibrating tension shall be noted and used in the installation of all bolts of the tested lot. Nuts shall be in tightening motion when torque is measured. When using calibrated wrenches to install several bolts in a single joint, the wrench shall be returned to "touch up" bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the prescribed amount.

Impact wrenches shall be of adequate capacity and sufficiently supplied with air to perform the required tightening in approximately ten seconds.

If required because of bolt entering and wrench operation clearances, tightening by either procedure may be done by turning the bolt while the nut is prevented from rotating, provided both bolt head and nut bear against surfaces having slopes not greater than 1:20.

(5) Inspection. The engineer shall satisfy himself that all requirements of the specification are met.

The engineer shall approve the procedure for calibration of wrenches and installation of bolts and shall further observe the field installation to determine these procedures are followed.

Spot checks should be made with a manual torque wrench that has been calibrated as previously specified herein.

(S) Riveting. Rivets shall be heated uniformly to a "light cherry red color" and shall be driven while hot. Any rivet whose point is heated more than the remainder shall not be driven. When a rivet is ready for driving, it shall be free from slag, scale and other adhering matter. Any rivet which, in the opinion of the engineer, is scaled excessively will be rejected. All rivets that are loose, burned, badly formed, or otherwise defective shall be removed and replaced with satisfactory rivets. Any rivet whose head is defective in size or whose head is driven off center will be considered defective and shall be removed. Stitch rivets that are loosened by driving of adjacent rivets shall be removed and replaced with satisfactory rivets. Caulking, recupping or double gunning of rivet heads will not be permitted.

Shop rivets shall be driven by direct-acting rivet machines when practicable. Approved beveled rivet sets shall be used for forming rivet heads on sloping surfaces. When the use of a direct-acting rivet machine is not practicable, pneumatic hammers of approved size shall be used. Pneumatic bucking tools will be required when, in the opinion of the engineer, the size and length of the rivets warrant their use. Rivets may be driven cold provided their diameter is not over $\frac{3}{8}$ inch.

(T) Edge Planing. Sheared edges of plates more than $\frac{5}{8}$ inch in thickness and carrying calculated stress shall be planed to a depth of $\frac{1}{4}$ inch. Re-entrant cuts shall be filleted before cutting.

(U) Welds. All welding shall conform to Specifications for Welded Highway and Railway Bridges of the American Welding Society, with subsequent amendments and additions thereto adopted by the Society.

If a fabricating shop prequalifies its metal-arc welding operators according to the standard qualification procedure of the American Welding Society and certifies to the engineer that an operator working on the structure has been prequalified within twelve months previous to the beginning of work on the subject structure, the engineer may consider such operator qualified. The certificate shall state that such operator has been doing

satisfactory welding of the required type within the three month period previous to the subject work. A certification shall be submitted for each operator and for each project, stating the name of the operator, the name and title of the person who conducted the examination, the kind of specimens, the positions of welds, the results of the tests and the date of the examination. Such a certification of prequalification may also be accepted as proof that an operator on field welding is qualified, if the contractor who submits it is properly staffed and equipped to conduct such an examination or if the examining and testing is done by a recognized agency which is staffed and equipped for such purpose.

(V) Flame Cutting. Steel or wrought-iron may be flame cut, provided a smooth surface is secured by the use of a mechanical guide. Flame cutting by hand shall be done only where approved by the engineer and the surface shall be made smooth by planing, chipping or grinding. The cutting flame shall be so adjusted and manipulated as to avoid cutting beyond the prescribed lines. Re-entrant cuts shall be filleted to a radius of not less than $\frac{1}{2}$ inch.

In the case of silicon steel, flame cut edges shall be removed to a depth of at least $\frac{1}{4}$ inch by milling, chipping or grinding, except that machine flame-cut edges may be used without such removal if the edges are softened after cutting; (a) by heating the cut edge uniformly and progressively to a red heat, visible in ordinary shop light ($1,150^{\circ}$ to $1,250^{\circ}$ F.) to a depth of at least $\frac{1}{16}$ inch; or (b) by means of a post-heating torch attached to and following the cutting torch; the tips, gas pressure, speed of travel and the distance of post-heating torch from kerf regulated to the thickness of the steel. Bend test specimens so cut and flame softened shall meet the bend test requirements for that thickness in ASTM A 94.

(W) Facing of Bearing Surfaces. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the surface roughness requirements as defined in A.S.A. B 46.1, Surface Roughness, Waviness and Lay, Part I:

Steel slabs	A.S.A. 2,000
Heavy plates in contact in shoes to be welded	A.S.A. 1,000
Milled ends of compression members, stiffeners, and fillers	A.S.A. 500
Bridge rollers and rockers	A.S.A. 250
Pins and pin holes	A.S.A. 125
Sliding bearings	A.S.A. 125

(X) Abutting Joints. Abutting joints in compression members and girder flanges, and in tension members where so specified on the drawings, shall be faced and brought to an

even bearing. Where joints are not faced, the opening shall not exceed $\frac{1}{4}$ inch.

(Y) End Connection Angles. Floor beams, stringers and girders having end connection angles shall be built to exact length back to back of connection angles. If end connections are faced, the finished thickness of the angles shall not be less than that shown on the detail drawings.

(Z) Lacing Bars. The ends of lacing bars shall be neatly rounded unless another form is required.

(AA) Finished Members. Finished members shall be true to line and free from twists, bends and open joints.

(BB) Web Plates. In girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than $\frac{1}{8}$ inch below any point. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates of girders having cover plates may be $\frac{1}{2}$ inch less in width than the distance back to back of flange angles.

Splices in webs of girders without cover plates shall be sealed on the top by welding.

At web splices, the clearance between the ends of the web plates shall not exceed $\frac{3}{8}$ inch. The clearance at the top and bottom ends of the web splice plates shall not exceed $\frac{1}{4}$ inch.

(CC) Bent Plates. Cold-bent load-carrying rolled-steel plates shall conform to the following:

(1) They shall be so taken from the stock plates that the bend line will be at right angles to the direction of rolling.

(2) The radius of bends, measured to the concave face of the metal, shall not be less and preferably shall be greater than shown in the following table, in which "T" is the thickness of the plate:

Angle through which plate is bent	Minimum radius
61 degrees to 90 degrees	1.0 T
91 degrees to 120 degrees	1.5 T
121 degrees to 150 degrees	2.0 T

If a shorter radius is essential, the plates shall be bent hot. Hot-bent plates shall conform to requirement (I) above.

(3) Before bending, the corners of the plate shall be rounded to a radius of $1/16$ inch throughout that portion of the plate at which the bending is to occur.

(DD) Fit of Stiffeners. End stiffener angles of girders and stiffener angles intended as supports for concentrated loads

shall be milled or ground to secure an even bearing against the flange angles. Intermediate stiffener angles shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within $\frac{1}{4}$ inch at each end. Welding will be permitted in lieu of milling or grinding if noted on the plans or specified in the special provisions. Welding transversely across the tension flanges of beams or girders, which have a flange stress of more than 75 per cent of their designed capacity, will not be permitted.

Horizontal stiffeners shall be of such length as to leave a gap no greater than $\frac{1}{2}$ inch between the vertical stiffeners and the end of the horizontal stiffeners.

(EE) Eyebars. Eyebars shall be straight, true to size, and free from twists, folds in the neck and head, and other defects. The heads shall be made by upsetting and rolling or forging, and not by welding. The form of the heads will be determined by the dies in use at the works where the eyebars are made, if they are satisfactory to the engineer. The thickness of the head and neck shall not overrun more than $1/16$ inch. Eyebars that are to be placed side by side in the structure shall be bored so accurately that upon being placed together, pins $1/32$ inch less in diameter than the pin holes will pass through the holes at both ends at the same time without driving.

(FF) Annealing and Stress Relieving. Before boring, eyebars shall be annealed to produce the required physical qualities and shall be straightened. Proper instruments shall be provided for determining at any time the temperature of the bars. Members, such as bridge shoes, pedestals, or other parts which are built up by welding sections of plate together, shall be stress relieved in accordance with the provisions of A.W.S. Crimped stiffeners need not be annealed.

(GG) Pins and Rollers. Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws. Pins and rollers more than 7 inches in diameter shall be forged and annealed. Pins and rollers 7 inches or less in diameter may be either forged and annealed or cold finished carbon-steel shafting.

In pins larger than 9 inches in diameter, a hole not less than 2 inches in diameter shall be bored full length along the axis after the forging has been allowed to cool to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling, and before being annealed.

(HH) Boring Pin Holes. Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut. The distance outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary from that specified more than $1/32$ inch. Boring

of holes in built-up members shall be done after the riveting is completed.

(II) Pin Clearances. The diameter of the pin hole shall not exceed that of the pin by more than $1/50$ inch for pins 5 inches or less in diameter, or $1/32$ inch for larger pins.

(JJ) Screw Threads. Threads for all bolts and pins for structural steel construction shall conform to the American National Coarse Thread Series, Class 2, free fit, except that the pin ends having a diameter of $1\frac{1}{8}$ inches or more shall be threaded 6 threads to the inch.

(KK) Pilot and Driving Nuts. Two pilot nuts and two driving nuts for each size of pin shall be furnished, unless otherwise specified. Pilot and driving nuts will not be required when shoes are assembled at the fabrication plant.

42.07 MILL AND SHOP INSPECTION. Materials are subject to inspection as specified under Section 48.

42.08 MARKING AND SHIPPING. **(A) Marking and Shipping.** Each member shall be painted or marked with an erection mark for identification and an erection diagram shall be furnished with erection marks shown thereon.

The contractor shall furnish, to the engineer, as many copies of material orders, shipping statements and erection diagrams as the engineer may direct. The weights of the individual members shall be shown on the statements.

Members weighing more than 3 tons shall have the weights marked thereon. Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed or otherwise damaged.

Bolts and rivets of one length and diameter and loose nuts or washers of each size shall be packed separately. Pins, small parts and packages of bolts, rivets, washers and nuts shall be shipped in boxes, crates, kegs or barrels, but the gross weight of any package shall not exceed 300 pounds. A list and description of the contained material shall be plainly marked on the outside of each shipping container.

(B) Handling Material. The loading, transportation, unloading, and storing of structural material shall be conducted so that the metal will be kept clean and free from injury.

42.09 ERECTION. **(A)** The contractor shall erect the metal work, remove the temporary construction, and do all the work required to complete the bridge or bridges as covered by the contract, including the removal of the old structure or structures, if stipulated, all in accordance with the plans and specifications.

(B) Masonry. If the substructure and superstructure are built under separate contracts, the State will provide the

masonry, constructed to correct lines and elevations and properly finished, and will establish the lines and elevations required for setting the steel.

(C) Plant. The contractor shall provide the falsework and all tools, machinery and appliances, including drift pins and fitting-up bolts, necessary for the expeditious handling of The Work.

(D) Handling and Storing Materials. Material to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection. If the contract is for erection only, the contractor shall check the material turned over to him against the shipping lists and report promptly in writing any shortage or injury discovered. He shall be responsible for the loss of any material while in his care, or for any damage caused to it after being received by him.

(E) Falsework. The falsework shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The contractor, if required, shall prepare and submit to the engineer for approval, plans for falsework or for changes in an existing structure necessary for maintaining traffic. Approval of the contractor's plans shall not be considered as relieving the contractor of any responsibility.

(F) Methods and Equipment. Before starting the work of erection, the contractor shall inform the engineer fully as to the method of erection he proposes to follow, and the amount and character of equipment he proposes to use, which shall be subject to the approval of the engineer. The approval of the engineer shall not be considered as relieving the contractor of the responsibility for the safety of his method or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be done until such approval by the engineer has been obtained.

(G) Bearing and Anchorage. Masonry bearing plates shall not be placed upon bridge-seat bearing areas which are improperly finished, deformed or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry. Unless otherwise directed, they shall be placed on a layer of canvas and red lead applied as follows:

Thoroughly swab the bridge-seat bearing area with a shop coat of red lead paint and place upon it three layers of 12 to 14 ounce duck, each layer being thoroughly swabbed on its top surface with shop coat red lead paint. Place the superstructure shoes or pedestals in position while the paint is plastic.

In setting shoes or bearing plates for steel truss spans

proper allowances shall be made for bottom chord elongation due to dead load.

Anchor bolt holes shall be drilled in the correct locations or may be formed by the insertion in fresh concrete of oiled wooden plugs, metal pipe sleeves or other approved devices which are subsequently withdrawn after the concrete has partially set. If the holes are drilled the anchor bolts shall first be dropped into the dry holes to assure their proper fit after setting. If the holes are correct the bolts shall then be removed and the holes shall be filled about 2/3 full of Portland cement grout and by a uniform, even pressure or by light blows with a hammer (flogging and ramming will not be permitted) force the bolt down until the grout rises to the top of the hole and the anchor bolt nut rests firmly against the metal shoe or pedestal. When the holes are formed by the latter method, they shall be not less than 4 inches in diameter to allow for horizontal adjustment of the bolts. The exact location of the anchor bolts shall then be determined and the anchor bolts shall be grouted in the holes with Portland cement grout. All excess grout shall be removed in order to permit proper painting of metal surfaces.

In lieu of the above specified methods of placing anchor bolts, they may be set to exact location in the concrete when it is placed. If this method is used great care shall be exercised to insure the proper setting of the bolts and any inaccuracies which will be detrimental to the structure shall be corrected by a means approved by the engineer.

The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at the time of erection. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit the free movement of the span.

(H) Straightening Bent Material. The straightening of plates and angles or other shapes shall be done by methods not likely to produce fracture or other injury. The metal shall not be heated unless permitted by the engineer, in which case the heating shall not be to a higher temperature than that producing a dark "cherry red" color. After heating, the metal shall be cooled as slowly as possible. Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

(I) Assembling Steel. The parts shall be accurately assembled as shown on the plans and any match-marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken, or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are

fully riveted and all other truss connections pinned and bolted. Rivets in splices of butt joints of compression members and rivets in railings shall not be driven until the span has been swung. Splices and field connections shall have one-half of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting. Splices and connections carrying traffic during erection shall have three-fourths of the holes so filled.

Fitting-up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be $1/32$ inch larger.

(J) Riveting. Pneumatic hammers shall be used for field riveting, except when the use of hand tools is permitted by the engineer. Rivets larger than $\frac{3}{8}$ inch in diameter shall not be driven by hand. Cup-faced dollies, fitting the head closely to insure good bearing, shall be used. Connections shall be accurately and securely fitted up before the rivets are driven. Drifting shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the metal. Unfair holes shall be reamed or drilled. Rivets shall be heated uniformly to a light cherry-red color and shall be driven while hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical, concentric with the shank, and shall have full bearing all around. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Caulking or recupping will not be permitted. In removing rivets, the surrounding metal shall not be injured; if necessary, they shall be drilled out. Field driven rivets shall be inspected and accepted before being painted.

(K) Bolted Connections. In bolted connections, the bolts shall be drawn up tight and the threads burred at the face of the nut with a pointed tool.

(L) Pin Connections. Pilot and driving nuts shall be used in driving pins. They shall be furnished with the steel work and shall be returned to the State on completion of The Work. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

(M) Misfits. Corrections of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets will be considered a legitimate part of the erection. Any error in shop work which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the inspector, and his approval of the method of correction obtained. The correction shall be made in the presence of the inspector, who will check the work and material. The contractor shall be responsible for all misfits, errors and injuries and shall make the necessary corrections and replacements.

(N) Removal of Old Structure and Falsework. If stipulated in the contract, the contractor shall dismantle the old structure and dispose of it as stipulated under Section 95.

Upon completion, and before final acceptance, the contractor shall remove all falsework, excavated or useless materials, rubbish and temporary buildings, replace or renew any fences damaged, and restore in acceptable manner all property, both public and private, which may have been damaged during the prosecution of his work, and shall leave the bridge site and adjacent Highway in a neat and presentable condition satisfactory to the engineer. All falsework piling shall be pulled or cut off 1-foot below finished ground line where conditions will permit. If conditions are not favorable for pulling or cutting off the piles as stated above, the piles shall be either broken or shot off at the stream bed, unless otherwise provided by the engineer. All excavated material or falsework placed in the stream channel during construction shall be removed by the contractor before final acceptance.

(O) Inspection. The Work shall be subject, at all times, to inspection by the engineer.

42.10 PAINTING. Painting shall be performed in accordance with Article 54.01, Article 54.05 and Article 54.06, Parts (A) and (B).

42.11 METHOD OF MEASUREMENT. The quantities of the various items which constitute the completed and accepted structure will be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing.

42.12 BASIS OF PAYMENT. The measured quantities, as provided above, will be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for furnishing, fabricating, welding, erecting, painting, hauling, and placing of all materials and for all labor, tools, equipment and incidentals necessary to complete the work. Such payment shall constitute full payment for the completed structure ready for use. Miscellaneous items not listed in the proposal but shown or billed on the drawings shall be included in the price bid for the other items. No additional allowance will be made for cofferdam construction, falsework, form lumber or other erection expense.

SECTION 43

TIMBER STRUCTURES

43.01 DESCRIPTION. Work and materials under this section shall consist of timber structures constructed in conformity with the plans or as ordered in writing, and in accordance with this and other specification items involved.

43.02 FIELD OFFICE. Unless specified otherwise, the contractor shall provide a field office, for the engineer, in accordance with the provisions of Article 05.08.

43.03 MATERIALS. **(A) Timber and Lumber.** All timber and lumber shall be of the species and grades called for on the plans and as specified in the special provisions.

(B) Hardware. Bolts, drift pins and dowels may be either wrought iron or medium steel. Washers shall be cast, ogee gray iron castings or malleable castings, unless cut washers are specified on the plans. Ring or shear plate timber connectors shall be of approved design and made of hot rolled low carbon steel ASTM A 17, Type "A" grade.

(1) Bolts. Bolts shall be of the sizes specified and must be perfect in every respect. They shall have square or carriage heads and square nuts, provided however, that large-head type timber bolts of approved design may be used. Screw threads shall make close fits in the nuts. The bolts provided shall be of proper length to project beyond nuts not more than $\frac{1}{2}$ inch nor less than $\frac{1}{4}$ inch. When bolts are not provided in the proper lengths, the bolts shall be cut off or rethreaded to comply with this requirement. All bolts shall be effectively checked after the nuts are adjusted.

(2) Washers. Washers shall be used between all bolt heads and nuts and the wood, except that carriage bolts, or large-head type timber bolts, shall have washers under nuts only. Cast washers shall have a thickness equal to the diameter of the bolt and a diameter of four times the thickness. For malleable or plate washers, the diameter or side size of the square shall be equal to four times and the thickness equal to one-half the diameter of the bolt. Cast iron washers shall be used when the timber is in contact with earth.

(3) Galvanized Hardware. All bolts, rods, hold-down straps, lag screws, turn bolts, cable clamps, anchor cable, all nuts and washers (except cast-iron washers), drains and sheet iron shall be galvanized by the hot dip method and shall have a continuous coating of pure zinc of a uniform thickness so applied that it will adhere firmly to all surfaces, and shall be capable of withstanding 4 immersions in a standard test solution of copper sulphate without showing any trace of metallic copper on the steel in accordance with the Preece Test, ASTM

A 239. The first 3 immersions shall be for a period of 1 minute each and the 4th immersion for a period of $\frac{1}{2}$ minute. Drift pins, dowels and nails may be furnished ungalvanized.

The contractor may use pure zinc sheets, aluminum, copper or any other approved non-rusting material of equal thickness in lieu of the Gage 22 galvanized sheets specified for capping the pile heads and flashing the drain openings. Aluminum or aluminum alloy sheets shall be installed using lead-headed nails or with lead washers under the heads of regular nails of the sizes specified.

(C) Bridge Iron. Steel truss rods, structural shapes, and plates shall conform to ASTM A 7. No welds in truss rods will be permitted. All plates or shapes which are heated to facilitate bending shall be properly annealed. Steel castings shall conform to ASTM A 27, Grade 65-35. Iron castings shall conform to ASTM A 48.

43.04 CONSTRUCTION METHODS. **(A) Handling of Materials.** Treated timber shall be carefully handled without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. It shall be handled with rope slings. Cant dogs, hooks, or pike poles shall not be used.

(B) Storage of Materials. Timber on the site of the work shall be stored in piles. The ground underneath and adjacent to material piles shall be cleared of weeds and rubbish. Untreated material shall be close-stacked at least 12 inches above the ground surface and piled to shed water and prevent warping. When required by the engineer, it shall be protected from the weather by suitable covering. Treated material shall be close-stacked to prevent warping.

(C) Treatment of Breaks. All places where the surface of treated timber is broken by cutting, boring, or otherwise, shall be thoroughly coated with hot creosote oil and then with a coating of hot tar.

(D) Temporary Attachment. Whenever, with the approval of the engineer, form or temporary braces are attached to treated timber, with nails or spikes, the holes shall be filled by driving galvanized nails or spikes flush with the surface, or plugging with creosoted plugs after treating with creosote oil.

(E) Bearing. Post and pile caps shall be level and have full even bearing on all posts or piles in the bent and be secured to each pile or post by a $\frac{3}{4}$ inch diameter drift pin extending at least 9 inches into the pile or post at the approximate center thereof.

(F) Sills and Mud Sills. Timber used for mud sills shall conform to the requirements shown on the plans or in the special provisions. Mud sills shall be firmly and evenly bedded to solid bearing and tamped in place. Sills shall have true and even bearing on mud sills, piles or pedestals. They shall be

drift-bolted to mud sills or piles with bolts of not less than $\frac{3}{4}$ -inch diameter and extending into mud sills or piles at least 6 inches. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

(G) Framing. Truss and bent timbers shall be accurately cut, and framed to a close fit in such manner that they will have even bearing over the entire contact surface of the joint. No blocking or shimming of any kind will be allowed in making joints, nor will open joints be accepted. Mortises shall be true to size for their full depth and tenons shall make snug fit therein.

Cross-bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least 2 nails in each end. All cross-bridging members shall have full bearing at each end against the sides of stringers. Unless otherwise specified on the plans, cross-bridging shall be placed at the center of each span.

Timber to be treated for preservation shall be cut and framed prior to treatment. No unnecessary cutting will be allowed after treatment.

(H) Bolt Holes. Holes for round driftpins and dowels shall be bored with a bit 1/16 inch smaller in diameter than the pin or dowel to be used. The diameters of holes for square driftpins or dowels shall be equal to the least dimension of the pin or dowel. Holes for bolts shall be bored with a bit of the same diameter as that of the bolt. Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread. Holes for rods shall be bored with a bit 1/16 inch greater in diameter than the rod. All holes in treated timber bored after treatment shall be treated with an approved pressure bolt hole treater; holes for rods shall be effectively sealed with hot tar or other suitable waterproofing after insertion of rods.

Countersinking shall be done wherever smooth faces are required. Horizontal recesses formed for countersinking shall be painted with hot creosote oil and, after the bolt or screw is in place, shall be filled with hot tar.

(I) Stringer Sizing. Stringers shall be sized at bearing only. Outside stringers shall have butt joints but interior stringers shall be framed to bear over the full width of floor beam or cap at each end. The ends shall be securely fastened to the timber on which they rest. When untreated timbers are used, they shall be separated at least $\frac{1}{2}$ inch for the circulation of air.

(J) Roadway Floors. Roadway floors shall be of the strip or laminated type and shall be surfaced S1S1E or S4S. Each lamina shall have a nominal thickness of 2 inches and a width as shown on the plans, and shall be full length except as otherwise permitted on the plans. Unless otherwise specified, they shall be sized to a uniform width and shall not vary in thickness from end to end. Each lamina shall be toe-nailed to alter-

nate stringers with 20d nails and face nailed to adjacent laminae with 20d nails at 18 inch center, staggered. Where splices are permitted, the splice shall be made on the centerline of a stringer and each piece shall be of sufficient length to bear on at least 4 stringers. Splices shall be made at any one stringer no oftener than every third lamina, and splices in adjacent laminae shall not occur on adjacent stringers. All floors shall be cut to a straight line along the sides of the roadway. Upon written permission, the contractor may adjust the spacing of stringers to reduce wastage in cutting laminated decking from commercial length timbers. Approval of the revised stringer spacings shall be obtained before work is started, but in no case shall the spacing of stringers in the center portion of the roadway exceed 27 inches for 2" x 4" decking.

(K) Surface Treatment of Deck. After laminated decking is laid, and curbs, with drains as specified, are completed, the entire top surface of deck and the inside surfaces of curbs, shall be treated with three coats of hot tar conforming to ASTM D 490, Grade RT-7 or RT-8 (RT-7 is adapted to cold weather application, RT-8 to warm weather application). This is a tar having a float of 50 to 120 seconds at 32°C.

The tar shall be heated in an open tank or kettle to a temperature between 200°F. and 225°F. and then applied evenly to the surfaces to be treated at the rate of $\frac{1}{4}$ gallon per square yard. Three coats shall be applied at this rate, each coat being given a sufficient time to cool and set up before the application of the succeeding coat is begun.

After the final coat of tar has had sufficient time to cool and set up, and before any vehicles are allowed on the structure, the entire surface of the deck shall be covered with aggregate surfacing at the rate of one cubic yard of material per 24 square yards of surface area. The aggregate surfacing shall conform to the requirements of Type "A", Grade 2 or 3, or Type "B", Grade 3, given in Section 25, except that crushing will not be required and the amount of material passing the 200-mesh sieve shall not exceed 10 per cent. The cost of all materials, equipment and labor necessary and incidental to this surface treatment of deck, as well as the materials and labor incidental to the construction of the drain openings in curbs, shall be included in the price bid per thousand feet board measure for treated or untreated lumber in place.

(L) Wheel Guards. Wheel guards shall be constructed as shown on the plans and shall be bolted to the outside stringers by $\frac{3}{4}$ inch machine or hook bolts spaced not more than 5 feet center to center. All joints shall be lapped and a bolt shall pass through each lapped joint. When the wheel guard is not blocked up from the floor, drain holes shall be provided at such intervals as to drain the roadway adequately. They shall be provided with galvanized iron lining and arranged so as to discharge free of the structure.

(M) Railing. Railing shall be built as shown on the plans and shall be constructed in a workmanlike and substantial

manner. Unless otherwise noted, all railing material shall be untreated timber and shall be dressed on 4 sides. All rail shall be squarely jointed at the posts and the rails shall break joints. Nailing of railing to posts will not be permitted.

43.05 PAINTING UNTREATED TIMBERS. This shall be done in accordance with the provisions of Article 54.06(C).

43.06 METHOD OF MEASUREMENT. The quantities of timber and other contract pay items in the completed and accepted structure shall be measured for payment in the manner prescribed for the several items involved.

43.07 BASIS OF PAYMENT. The quantities of the several contract pay items as measured above, except truss spans, shall be paid for at the contract unit prices bid, per lineal foot, for the several items involved, complete in place, according to the plans, or as directed in writing, which prices shall be full compensation for all material, tools, equipment, labor and all incidentals necessary to complete the structure ready for use.

Timber trusses complete shall be paid for at the prices bid per span complete, as shown on the plans, which shall include all parts of the bridge except abutments and piers. This price shall be full compensation for all materials, structural steel, steel or iron castings, hardware, equipment, tools, labor, painting, preservative treatment, surface treatment of deck, and all incidentals necessary to complete the structure ready for use.

SECTION 45

EXCAVATION FOR STRUCTURES

45.01 DESCRIPTION. "Excavation for Structures" shall consist of all excavation for foundations for bridges, and all other major structures, and shall include the disposal of all material obtained from such excavation and backfilling to the level of the original ground. Unless otherwise specified by the plans and/or special provisions, it shall also include all necessary bailing, drainage, sheeting, and the construction of cribs or cofferdams if found necessary. The excess material shall be disposed of as directed and in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other parts of the work.

45.02 CLASSIFICATION. All material excavated shall be unclassified and paid for as unclassified excavation for structures, unless otherwise provided in special provisions. The excavation lines and bases of structures shown on the plans shall be considered as approximate only, and they may be ordered in writing by the engineer to be placed at any elevations, or of

any dimensions necessary to give a satisfactory foundation, and no additional compensation will be allowed for any such alteration except as provided under Article 45.05.

Boulders, logs, or any unforeseen obstacles encountered in excavating shall be removed and no additional compensation will be allowed for driving through or removing such obstructions.

All timber, sheeting, and other material used in making the excavation shall be removed except as ordered by the engineer, and the cost of performing this work shall be considered as included in the unit price bid for unclassified excavation for structures.

45.03 CONSTRUCTION METHODS. **(A) Depth.** All foundation excavation shall be carried to a depth satisfactory to the engineer, regardless of the elevations shown on the plans, and unsuitable material shall be replaced with approved material if required. If rock bottom is secured, the excavation shall be done in such a manner as to allow the solid rock to be exposed and prepared in horizontal beds for receiving the structure, except that for arch substructures, the bottom shall be sloped or stepped as directed. All rock or hardpan foundation surfaces shall be freed from loose or disintegrated pieces, thin strata shall be removed, and the surfaces cut to firm bearing and cleaned to the satisfaction of the engineer.

(B) Treatment of Foundation Materials. Where concrete or masonry is to be placed on any excavated surface, special care shall be taken not to disturb the bottom of the excavation more than necessary, and the final removal of the material to grade shall not be made until just before the concrete or masonry is laid. All seams or crevices shall be cleaned out and filled with concrete mortar. When the excavation is at the required depth, water, if present, shall be pumped out, if possible, for cleaning the foundation bed for inspection. The natural ground adjacent to the structure shall not be disturbed without permission of the engineer. The existing ground surface at and adjacent to each unit of the substructure shall not be disturbed except as necessary for the sinking of the cofferdams, and all excavation shall be restricted to the area inside of the cofferdams, unless otherwise approved.

(C) Cofferdams. Cofferdams or cribs for foundation construction shall, in general, be carried well below the bottom of the footings and shall be well braced and as water-tight as practicable. In general, the interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside of the forms. Cofferdams or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance and this shall be at the sole expense of the contractor. Cofferdams shall be constructed so as to protect green concrete

against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. No timber or bracing shall be left in cofferdams or cribs in such a way as to extend into the substructure masonry, without written permission.

When required, the contractor shall submit drawings showing his proposed method of cofferdam construction and other details left open to his choice nor not fully shown on the plans. Such drawings shall be approved before construction is started, but such approval shall not in any way relieve the contractor of his responsibility to secure a safe and satisfactory cofferdam.

When conditions are encountered which, in the opinion of the engineer, render it impracticable to unwater the foundation before placing masonry, he may require the construction of a concrete foundation seal of such dimensions as may be necessary. The foundation shall be pumped out and the balance of the masonry shall be placed in the dry. When weighted cribs are employed and the weight utilized to partly overcome the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal. When a foundation seal is placed under water, the cofferdam shall be vented or ported at low water level.

Unless otherwise provided, cofferdams or cribs with all sheeting and bracing shall be removed by the contractor after the completion of the substructure. The removal shall be effected in such a manner as not to disturb or mar the finished masonry.

(D) Pumping. Pumping from the interior of any foundation enclosure shall be done in such manner as to preclude the possibility of any portion of the concrete materials being carried away. No pumping will be permitted during the placing of concrete, or for a period of at least 24 hours thereafter, unless it be done from a suitable sump separated from the concrete work by a water-tight wall. Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

(E) Inspection. After each excavation is completed, the contractor shall notify the engineer, and no footing shall be placed until he has approved the depth of the excavation and the character of the foundation material.

When required, the contractor shall drill holes or drive rods in the bottom of the footings to ascertain the quality of the material.

(F) Backfilling. All spaces excavated and not occupied by abutments, piers or other permanent work shall be refilled with earth up to the surface of the surrounding ground, with a sufficient allowance for settlement. Where the backfill is to carry the roadway embankment or any part thereof, the back-

fill shall be made in continuous horizontal layers not greater than 8 inches in thickness, and each layer shall be thoroughly compacted by mechanical or hand tamping before the succeeding layer is placed as specified by pertinent provisions of Sub-section 11.80. All other backfill shall be thoroughly compacted and its top surface shall be neatly graded.

All material used for backfill shall be approved before use and shall be free from large or frozen lumps, wood or other extraneous material. In general, this material shall be selected from the material excavated in connection with the substructure involved. Jetting or ponding of the backfill will not be permitted. Water shall be used to expedite settlement of the backfill only when it is difficult to compact the materials, and ordered by the engineer.

The slope bounding the excavation for abutments and wing walls shall be destroyed by stepping or serrating to prevent wedge action.

Adequate provision shall be made for thorough drainage of all backfill by placing coarse gravel or broken stone around drain holes in wing and abutment walls as specified under Section 60 or shown on the plans.

For foundations through hard material exposed to erosion, the backfill around piers and in front of abutments and wings shall be made of the larger and heavier material selected from material removed from the excavation. If acceptable material is not available in sufficient quantity, the engineer may order said backfill to be made of stone or lean concrete; in which case, unless otherwise provided, this backfill shall be paid for as extra work.

No backfill shall be placed against any masonry abutment, wing wall or culvert until permission shall have been given, and preferably not until the masonry has been in place 14 days.

The cost of performing this work shall be considered as included in the unit price bid for unclassified excavation for structures.

(G) Spandrel Fill. The spandrel fill of arch bridges shall be considered a part of the road embankment, shall be composed of earth or gravel, and shall be placed in layers of variable thickness simultaneously over all piers, abutments and arch rings. The lower six inches of material in direct contact with the arch ring waterproofing shall be of fine grading to avoid injury to the waterproofing. At all points the ratio of thickness of each layer to the total depth of the proposed fill shall be approximately constant. The maximum thickness of any layer shall not exceed 18 inches. This work shall be paid for at the contract unit price bid per cubic yard for unclassified excavation or borrow.

(H) Approach Embankments. When the contract for any bridge structure involves the placement of approach embank-

ments, these shall be constructed and paid for in accordance with the specifications governing this class of work.

45.04 METHODS OF MEASUREMENT. The quantity of excavation for which payment will be made will be the volume in place within vertical planes, 18 inches outside of neat lines of footings, from the surface of the ground as it exists at the time when excavation is started, to the elevation shown on the plans, or to such elevation as the engineer may direct, unless otherwise indicated on the plans or in the special provisions. In case of tie beams, overhangs, or similar construction which extend beyond the footing lines, measurement of excavation shall be limited to 18 inches outside and below neat lines and parallel thereto, provided that the space so measured for payment shall include only that portion not measured for payment under the above paragraph. When the items of work covered by this section are bid on a lump sum basis there will be no measurement of quantities.

45.05 BASIS OF PAYMENT. Payment for shoring and cribs will be made at the lump sum price bid, which shall be full compensation for The Work, including the construction and subsequent removal of all shoring, cribs, cofferdams and caissons. When it is necessary, in the opinion of the engineer, to carry the foundations below the elevations shown on the plans, no additional compensation over the lump sum price bid will be made for increased depth to and including a depth of three feet below plan elevations. If a depth greater than three feet below plan elevations is required, allowance for extra cost below the additional three foot depth may be made, based upon the actual cost to the contractor for increasing the height of cofferdams or cribs or for their re-construction. Payment for structure excavation, measured as provided above, shall be made at the contract unit price bid per cubic yard, or on a lump sum basis, for unclassified excavation for structures, which price and payment shall be full compensation for The Work unless otherwise indicated on the plans or in the special provisions.

When it is necessary, in the opinion of the engineer, to carry the foundations below the elevations shown on the plans, the excavation for the first three feet of additional depth will be included in the quantity for which payment will be made under the item "Structure Excavation."

Excavation below this additional depth will be paid for on the basis of extra work or at the contract price, as the contractor may elect, such choice to be made in writing before work is commenced.

The foregoing provisions shall apply to all and any increased quantities of excavation resulting from the lowering of bridge footings.

SECTION 46

PORTLAND CEMENT CONCRETE

46.01 DESCRIPTION. Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, and water, prepared and constructed in accordance with the specifications, at the locations and of the form, dimensions, and classes shown in detail on the plans; provided, in addition, that any concrete described on the plans as air-entrained concrete also shall meet the requirements set forth herein.

(A) **Air-Entrained Concrete.** Air-entrained concrete shall be used in all parts of the structure unless otherwise indicated on the plans. This shall be a concrete containing an air-entrained admixture and not an air-entraining Portland cement.

(1) **Admixtures.** When an air-entraining admixture is used, the engineer will determine by trial the amount of admixture required to produce concrete having the specified air content and this amount shall not be varied except as directed by the engineer.

(2) **Proportions and Batch Weights.** The engineer shall determine the proportions and batch weights for air-entrained concrete in the manner prescribed in Article 46.03 for regular concrete; provided, however, that in making such adjustments as may be necessary by reason of entrained air, the engineer will use the minimum quantity of fine aggregate and the minimum quantity of water which, in his judgment, will produce concrete of the required workability.

(3) **Entrained air.** Air-entrained concrete shall contain not less than 4% nor more than 7% entrained air, as determined by AASHO T 152. Aggregates having a maximum size of $1\frac{1}{2}$ to $2\frac{1}{2}$ inch shall receive plus or minus 5% entrained air; $\frac{3}{4}$ to 1 inch aggregate shall receive plus or minus 6% air. Tests for entrained air shall be made by the engineer on concrete containing the materials to be used in The Work and employing the type of mixer and mixing procedure which will be used in construction.

46.02 CLASSIFICATION. Concrete will be classified as set forth below. Each class of concrete shall be used in that part of the structure in which it is called for on the plans, where specified or where directed. The following requirements shall govern unless otherwise shown on the plans.

Class "A" concrete shall be used for reinforced substructures, retaining walls and box culverts.

Class "AD" concrete shall be used for all superstructures, except where Class "DD" is specified on plans.

Class "AP" concrete shall be used for concrete pavement on streets and highways and for similar purposes.

Class "DD" concrete shall be used for sections less than 5 inches in thickness.

Class "F" concrete may be used as setting for metal fence posts and braces and other situations where concrete of high quality is not necessary.

Class "S" concrete shall be used for all concrete deposited under water. The concrete of the various classes shall be designed so as to secure concrete which will meet the requirements of Table A — Classes of Concrete.

Note: Provisions concerning Class "F" concrete occur in Article 46.03, Part (Q) of Article 46.05, Article 46.07 and Article 46.08. When forms and reinforcing steel are required the provisions of this section in general shall apply.

TABLE "A" — CLASSES OF CONCRETE

Class	Minimum Compressive Strength		Maximum Size of Aggregate
	7 days Lb. per sq. in.	28 days Lb. per sq. in.	
A	1,600	2,400	1½
AD	2,000	3,000	1½
AP	2,500	4,000	1½
DD	2,000	3,000	¾
F			1½
S	1,600	2,400	1½

The strengths shown in Table A are the strengths below which not more than 10% of all tests may fall.

46.03 COMPOSITION OF CONCRETE AND PROPORTIONING. Immediately upon receipt of the ward of the contract, the contractor shall furnish the engineer exact locations of sources of materials which he proposes to use, excepting when Class "F" is specified or is to be used. The engineer shall forward samples to the laboratory for testing. When materials are satisfactory the laboratory will determine the proportions and blends of aggregates and cement that will give the maximum durability and strength compatible with workable concrete.

When Class "F" concrete is to be used the engineer shall approve the aggregates but it is not mandatory that samples be sent to the laboratory.

The contractor shall put into each batch the amount of cement and the amount of water and shall weigh into each batch

the respective weights of fine and coarse aggregate designated by the engineer for the particular material being used and the class of concrete being made; except that in batching aggregates for structures containing less than 10 cubic yards of concrete, the contractor may substitute approved volumetric measuring devices in lieu of weighing devices. In such event, weighing will not be required but the volume of coarse aggregate and fine aggregate measured into each batch shall be those designated by the engineer.

Materials shall be proportioned by either method "A" or "B" given below. Method "B" shall be used except where Method "A" is specifically authorized by the special provisions.

(A) Method "A". Using Master Proportion Table. The engineer, subject to the requirements of the "Master Proportion Table," shall designate the respective amounts of the job materials to be used in the batch. The sum of the weights of fine and coarse aggregate designated for each class of concrete shall equal the "FIXED" weights shown in the "Total Aggregate" column for the respective classes of concrete either air free or air entrained. Within the ranges of the table, the engineer shall designate the weight of fine aggregate which, using the materials furnished, will produce a workable mix of the consistency specified, with the least amount of water.

The proportions by weight given in the master proportion table are based on the maintenance of a constant water-cement ratio. The weights shown are based on the use of aggregates having bulk saturated surface dry specific gravity of 2.65. If gravities of materials used vary from this figure by .05 or more, correction shall be made by multiplying the figures shown in the table by the new gravity and dividing by 2.65. The bulk specific gravity test shall be made in accordance with AASHO T 84 and T 85.

Since the weights given in the table are computed for aggregates in the dry condition, the batch weights must be corrected for any moisture present in the aggregates as delivered to the measuring bin. Absorption tests shall be made in accordance with AASHO T 84 and T 85.

The weights of fine and coarse aggregate will be adjusted by the engineer to insure concrete of satisfactory plasticity and workability, using not more than the maximum permissible net water content shown. During the progress of The Work, the total weight of aggregate per bag of cement shall not be changed except under the following conditions:

(1) If concrete of satisfactory plasticity and workability cannot be made without exceeding the maximum net water content, the engineer shall reduce the total weight of aggregate by an amount sufficient to insure that the maximum net water content will not be exceeded, and the contractor shall not receive additional compensation for any extra cement which may be necessary by reason of such adjustment.

MASTER PROPORTION TABLE

Class	Maximum Size of Coarse Aggregate Sq. Mesh	Minimum Cement Factor	Bags (94 lbs.) per yd.	Lbs.	Lbs.	Weight of Fine Aggregate Per Bag of Cement Min.	Weight of Total Aggregate Per Bag of Cement Max.	Air Free	Air Ent. 3½ Pct.	Gallons	Inches	Inches	Consistency Range In Slump
													Placing Without Vibration
ROUND COARSE AGGREGATE													
A	1½	5.5	190	230	595	570	6.0	1½-3					
AD	1½	6.5	135	165	470	450	6.0	1½-3					
AP	1½	6.0	190	230	595	570	6.0	1½-3					
DD	¾	6.5	145	175	470	450	6.0	1½-3					
S	1½	7.0	120	140	425	405	6.0	4-8					
ANGULAR COARSE AGGREGATE													
A	1½	5.5	225	275	595	570	6.0	1½-3					
AD	1½	6.5	170	210	470	450	6.0	1½-3					
AP	1½	5.5	225	275	595	570	6.0	1½-3					
DD	¾	6.5	180	220	470	450	6.0	1½-3					
S	1½	7.0	155	185	425	405	6.0	4-8					

Mix design will be specified by the laboratory for each project.

Note — Using the maximum allowable water content, the weights given above, when multiplied by the corresponding cement factors, will furnish a cubic yard of concrete.

(2) If, during the progress of The Work, the specific gravity of one or both of the aggregates changes, the batch weights shall be changed accordingly.

(B) Method "B". Proportions Based on Laboratory Design.

The engineer shall furnish to the laboratory, samples or approved sample numbers on which the design is to be based. The proportions of cement, aggregates and water necessary to conform to these specifications shall be determined by means of preliminary laboratory tests on concrete made with the cement and aggregates which are to be used in The Work. The minimum cement factor shall be as set forth in the table below. For each class of concrete, the proportions of cement, fine and coarse aggregate, and the quantity of mixing water will be designed by the laboratory so as to meet the requirements of the proportioning table.

The strengths shown in the proportioning table are the strengths below which not more than 10% of all tests may fall.

The designated proportions shall be used so long as the materials are actually furnished from the sources originally named and so long as they continue to meet the requirements herein specified, subject only to slight changes in the relative quantities of fine and coarse aggregate for the purpose of promoting workability and correcting for moisture in the aggregates.

If, during the progress of The Work, the contractor wishes to use materials for which no approval or mix designs have been designated, the engineer shall secure samples of the new source and submit them to the laboratory for approval and new mix designs.

If, during the progress of The Work, it is found impossible to obtain concrete of the required workability with the designated proportions, the engineer may make such changes in proportions as are deemed necessary to secure the desired workability, provided that in no case shall the ratio of water to cement be greater than is specified in the table above for the class of concrete involved.

When Class "F" concrete is to be used the mixture shall consist of one part Portland cement, two parts clean, hard, sharp sand that will pass a $\frac{1}{4}$ inch screen and four parts of clean, broken stone or gravel uniformly graded between $\frac{1}{4}$ inch and $1\frac{1}{2}$ inch gradings. Measurement may be by volume. Water shall be clean, free of sewage, oil, acid and alkalis and the amount used shall not exceed six gallons per sack of cement. The materials must be approved by the engineer.

PROPORTIONING TABLE

Class	Maxi- num Size of Coarse Aggre- gate Square Mesh	Min- imum Cement Content 94 lb. Bags	7 Days	28 Days	Maximum Net Water Content Per Bag of Cement		Consistency Range in Slump	Placing Without Vibra- tion
					Lbs. Per Sq. In.	Lbs. Per Sq. In.		
A	1½	5.5	1,600	2,400	6.0	6.0	1½-3	
AD	1½	6.5	2,000	3,000	6.0	6.0	1½-3	
AP	1½	6.0	2,500	4,000	6.0	6.0	1½-3	
DD	¾	6.5	2,000	3,000	6.0	6.0	1½-3	
S	1½	7.0	1,600	2,400	6.0	6.0	4-8	

Mix design will be specified by the laboratory for each project.

46.04 MATERIAL. **(A) Cement and Admixtures.** The cement used in The Work shall be a Portland cement of the type or types shown on the plans, provided, however, that when not so shown, the type or types used shall be Type II for regular concrete.

(1) Cement. Portland cement shall conform to the requirements of AASHO M 85, Type I, II, III, IV or V as the case may be.

Low-alkali Portland cement shall conform to the requirements of AASHO M 85 for Type II with the additional requirement that the total alkali content calculated as the percentage of sodium oxide (Na_2O) plus 0.658 times the percentage of potassium oxide (K_2O) shall not exceed 0.6.

Only one brand of any one type of cement shall be used on the contract except by written permission by the engineer. If more than one brand or grade is permitted by the engineer, each shall be stored separately and shall not be used alternately in any pour. Different shipments of cement shall also be stored separately. The contractor shall provide suitable means for storing cement and protecting it from dampness.

Bags of cement, in which for any reason the cement has become partially set or which contain lumps of caked cement, shall be rejected; provided, however, that the cement from such bags, which is not partially set, caked or otherwise damaged, may be salvaged and used as bulk cement.

(2) Air-Entraining Admixtures. An air-entraining agent shall be added to the concrete mixture unless specified otherwise.

Air-entraining concrete shall be used in those parts of the structure or structures as indicated on the plans, and cement used shall be Type II with an approved air-entraining agent added by the contractor.

Type II-A cement will not meet the above requirement.

Before any air-entraining admixture can be used, evidence based on tests made in a recognized laboratory shall be submitted to show that the material conforms to the requirements of the latest revision of AASHO M 154 (ASTM C 260) for 7- and 28-day compressive and flexural strengths and resistance to freezing and thawing, except as provided in the following paragraph. Tests for bleeding, bond strength and volume change will not be required. A recognized laboratory is any State Highway, Bureau of Public Roads or cement and concrete laboratory regularly inspected by the Cement Reference Laboratory of the National Bureau of Standards. Tests may be made upon samples taken from a quantity submitted by the contractor for use on the Project or upon samples submitted and certified by the manufacturer as representative of the admixture to be supplied.

An exception to the requirements in the preceding paragraph is the case of admixtures which are manufactured by

neutralizing Vinsol resin with caustic soda (sodium hydroxide). When the contractor proposes to use such an admixture he shall submit a certification concerning the admixture in the following form:

"This is to certify that the product (trade name) as manufactured and sold by the (company) is an aqueous solution of Vinsol resin that has been neutralized with sodium hydroxide. The ratio of sodium hydroxide to Vinsol is one part of sodium hydroxide to (number) parts of Vinsol resin. The percentage of solids based on the residue dried at 105°C. is (number). No other additive or chemical agent is present in this solution."

When the contractor proposes to use an air-entraining admixture which has been previously approved, he shall submit a certification stating that the admixture is the same as that previously approved. If an admixture offered for use is essentially the same (with only minor differences in concentration) as another previously approved material, a certification will be required stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.

Either prior to or at any time during construction, the engineer may require that the admixture selected by the contractor be further tested to determine its effect upon the strength of the concrete. When so tested, compressive strength at 7 days of concrete, made with the cement and aggregate and in the proportions to be used in the work and containing the admixture under test in an amount sufficient to produce from 4 to 7 per cent entrained air in the plastic concrete, shall not be less than 88 per cent of the strength of the concrete with the same materials and with the same cement content and consistency but without the admixture. The percentage reduction in strength shall be calculated from the average strength of at least 5 standard 6" x 12" cylinders of each type of concrete. Specimens shall be made and cured in the laboratory in accordance with AASHO T 126, and shall be tested in accordance with AASHO T 22. The percentage of entrained air shall be determined in accordance with AASHO T 152. Admixtures failing to meet these requirements may be rejected.

A sufficient quantity of any of the approved agents shall be added with the mixing water for each sack (94 pounds) of cement used in a batch of concrete to insure compliance with specification with regard to air content. Should the contractor elect to use an approved metering device, he may use such other dilutions and quantities of solutions as the engineer determines will result in the proper control of the amount of air-entraining agent.

Air-entraining concrete shall contain not less than four (4) nor more than seven (7) per cent entrained air as determined by standard tests for air content, either by means of water displacement or pressure method. See Art. 46.01(A)(3).

When mix designs are furnished by the laboratory, they will make the necessary adjustments in weights of aggregates used per sack of cement as required to compensate for increased yield resulting from air entrainment.

When mixes are designed in the field, these adjustments shall be made by the engineer. They usually amount to about 3% of total batch weight. In making such adjustments as may be necessary by reason of entrained air, the engineer will use the minimum quantity of fine aggregate and the minimum quantity of water which, in his judgment, will produce concrete of the required workability. The concrete as placed shall have a slump not to exceed 3". The engineer should show, on the form to accompany cylinders, both the mix as designed by the laboratory and the mix actually used.

(3) Admixtures. If advance written permission is obtained from the engineer, an admixture other than those for air-entraining may be used for the purpose of retarding initial set, or for the reduction of the amount of mixing water required. No admixture shall be considered for approval which cannot show either certified laboratory test results or satisfactory field performance records to substantiate any and all claims made for the product. Use of admixtures which contain calcium chloride will not be permitted. If a water reduction of at least 5% is made through the use of an admixture, a cement reduction may be made not to exceed 10% of the required cement content for all classes of concrete (except Class "S"), with the provision that in no case shall the resulting water cement ratio exceed 0.53 or 6 gallons per sack of cement, and further, that strengths are maintained in accordance with the table shown under Article 46.02.

When an admixture is to be used, this fact must be made known to the laboratory as a part of the information supplied on aggregate sample sheets. The type of admixture must be shown. This information will make it possible for the laboratory to make the necessary adjustments in the mix designs. In no case shall mixes be adjusted in the field except for moisture in materials.

(B) Water. All water used in concrete shall be subject to the approval of the engineer and shall be reasonably clear and free from oil, acid or alkali and vegetable substances, and shall not be brackish or salty. Water of doubtful quality shall be tested in briquettes as prescribed by AASHO T 26, and the strength of such briquettes shall be equal to similar briquettes made of water of known satisfactory quality.

(C) Aggregate. To insure uniformity of grading, the gradation requirements given in this specification represent the extreme limits which shall determine suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform and not subject to the extreme percentages of gradation specified herein. For the purpose of determining the degree of uniformity, a fineness modulus de-

termination shall be made upon representative samples, submitted by the contractor from such sources as he proposes to use. Fine aggregate from any one source having a variation in fineness modulus greater than 0.20 either way from the fineness modulus of the representative sample submitted by the contractor may be rejected.

Aggregates shall be stored in compartmented bins, or some positive means shall be used to prevent the inclusion of foreign material and segregation. The different kinds of aggregates, if stockpiled, shall be separated, and stockpiles of coarse aggregate shall be built up in successive horizontal layers not more than 3 feet thick.

Each layer shall be completed before the next is started. Should segregation occur, the aggregate shall be remixed to conform to the grading requirements.

When ready-mixed concrete is used, stockpiles of acceptable aggregate shall be established at the plant supplying the concrete. It will not be permissible to use aggregate directly from the ready-mixed companies' stockpiles which are changing through the addition of daily production and withdrawal for commercial sales.

(1) Fine Aggregate. The fine aggregate for concrete shall consist of sand or a combination of sand and stone screenings; it shall be clean, hard, durable, uncoated grains and shall meet the requirements of AASHO M 6, except as modified below:

The fine aggregate shall be uniformly graded from fine to coarse and shall meet the requirements of the following table:

Passing $\frac{3}{8}$ -inch sieve	100%
Passing 4 mesh sieve	95-100%
Passing 8 mesh sieve	65- 95%
Passing 16 mesh sieve	35- 80%
Passing 50 mesh sieve	5- 30%
Passing 100 mesh sieve	0- 10%
Weight removed by elutriation test, Not more than	3%

The maximum amounts of deleterious substances in the fine aggregate shall not exceed the following limits:

	Maximum Limits
Coal and Lignite	0.25%
Clay Lumps	0. 5%
Shale and light particles (Specific Gravity under 2.0)	1. 0%
Other deleterious substances such as alkali, mica, coated grains, soft flakey particles, etc.	1. 0%
The sum of the percentages of all deleterious materials shall not exceed	4. 0%

Tests for Soundness. When the fine aggregate is subjected to five (5) cycles of sodium or magnesium sulfate, the weighted loss shall not exceed 10% and 15% respectively.

(2) Coarse Aggregate. The coarse aggregate for all classes of concrete shall consist of broken stone or gravel conforming to the requirements of AASHO M 80, except as modified below:

Coarse aggregate shall be furnished in two separate sizes: The No. 4 mesh to 2" size separated at the 1" sieve, and No. 4 mesh to 1½" size separated at the ¾" size.

Coarse aggregate, whether produced from rock or gravel, shall have a per cent of wear not to exceed 35 at 500 revolutions as determined by AASHO T 96.

Coarse aggregate shall be uniformly graded between the limits specified and the sizes designated shall conform to the requirements of the following table, when tested by means of laboratory screens:

Designated Sizes	Percentage by Weight Passing Laboratory Sieves Having Square Openings							
	2	1½	1¼	1	¾	½	⅜	No. 4
No. 4 to ¾"				100	90-100	40-75	20-55	0-10
No. 4 to 1½"	100	95-100	70-95		35-70		10-30	0- 5
¾" to 1½"	100	90-100	55-90	20-55	0-15			

It is the intent of these specifications that there shall be a portion of the material above the minimum gradation shown in each designated size.

(Attention is called to the fact that the shape of aperture specified in determining compliance with specifications for size of coarse aggregate has no relation to the size and shape of the aperture or type of screen used in the production of the material.)

The minimum amounts of deleterious substances in the coarse aggregate shall not exceed the following limits:

	Maximum Limits
Material passing 200 mesh	1.00%
Coal and Lignite	0.25%
Clay Lumps	0.25%
Shale	1.00%
Soft fragments	3.00%
Thin elongated particles (Having a length greater than 5 times Thickness)	15.00%
Other deleterious substances such as alkali, coated or friable particles, etc.	3.00%
The maximum amount of any combination of the deleterious substances shown above, excluding thin or elongated particles, shall not exceed	5.00%

Test for Soundness. When the coarse aggregate is subjected to five (5) cycles of sodium sulfate or magnesium sulfate, the weighted loss shall not exceed 12% and 18% respectively.

(D) Sampling Aggregates. The fine and coarse aggregates shall be sampled in accordance with the method described in AASHO T 2.

(E) Testing Concrete. The concrete for test purposes shall be made with the fine and coarse aggregate and the cement proposed for use on the work, and the concrete shall be mixed to the same consistency as will be used in the construction. Test cylinders cast in the laboratory shall be made and cured in accordance with AASHO T 126 and cylinders made in the field shall be cast and cured in accordance with AASHO T 23. Testing of concrete cylinders shall be in accordance with AASHO T 22. The average of the strengths of three consecutive cylinders shall constitute a test.

46.05. CONSTRUCTION METHODS. **(A)** Falsework for supporting concrete work shall be built on foundations of sufficient strength to carry the loads without appreciable deformation. Falsework which cannot be founded on solid footings must be supported by ample falsework piling. Falsework shall be designed to carry the full loads coming upon it. All spans shall be given a temporary camber sufficient to allow for shrinkage and settlement. Bridges shall have a permanent camber only when shown on the plans. If appreciable settlement occurs in the falsework, the work shall be stopped, any masonry affected shall be removed and the falsework rebuilt. In general, double wedges or other suitable means shall be provided for constructing and maintaining falsework and forms to correct lines.

If requested by the engineer, detail drawings of the falsework shall be submitted to the engineer for approval, but such approval shall not relieve the contractor of any of his responsibility under the contract for the successful completion of the improvement. Arch centering shall be so constructed as to permit of its being gradually and uniformly lowered or released after pouring the arch ribs or rings.

(B) Forms. Forms shall be so designed and constructed that they may be removed without injury to the concrete. Forms for all exposed concrete surfaces shall be made either of tongue-and-groove matched lumber of uniform width and thickness, surfaced inside to form a smooth and uniform surface, or shall be lined with plywood, using sheets of uniform size and thickness. Where forms are lined with plywood, all joints, holes, or other surface irregularities shall be filled with an approved joint filler and sanded to a smooth and uniform surface. For exposed concrete surfaces, only one type of form construction shall be used in any one form or forms for similar units of the structure. Undressed lumber may be used for backing or for surfaces which will not be exposed in the fin-

ished structure. All lumber shall be free from knot holes, loose knots, cracks, splits, warps or other defects affecting the strength or appearance of the finished structure. Form lumber shall be free from bulge or warp, and shall be thoroughly cleaned if used a second time. Forms for re-entrant angles shall be chambered and forms for edges shall be filleted unless otherwise required by plans or engineer.

In designing forms and centering, the concrete shall be treated as a liquid weighing 150 pounds per cubic foot for vertical loads, and not less than 85 pounds per cubic foot for horizontal pressure. The unsupported length of wooden columns and compression members shall not exceed 30 times the diameter or least side.

The forms shall be so designed that portions where finishing is required may be removed without disturbing portion of forms which are to be removed later and, as far as practicable, so that form marks will conform to the general lines of the structure. Column form marks shall be vertical and symmetrically placed.

When possible, forms shall be daylighted at intervals not greater than 10 feet vertically, the openings being sufficient to permit free access to the forms for the purpose of inspecting, working and spading the concrete.

All forms shall be set and maintained true to line and grade until the concrete is sufficiently hardened. The interior surfaces of forms shall be adequately oiled to insure non-adhesion of mortar. The forms shall be mortar-tight, and if necessary to close cracks due to shrinkage shall be thoroughly soaked with water. Forms shall remain in place for periods which shall be determined as hereinafter specified. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the engineer shall order the work stopped until the defects have been corrected. Immediately before placing concrete, all extraneous material within the forms shall be removed. For narrow walls and columns, where the bottom of the form is inaccessible, cleanout ports shall be provided at the top surface of concrete where a stoppage of placing occurs.

Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 1 inch from the face without injury to the concrete. All fittings for metal ties shall be of such design that, upon their removal, the cavities which are left will be of the smallest possible size.

(C) Handling, Measuring and Batching Materials. Concrete of the classes indicated shall be made up of acceptable material batched in the proportions set by the engineer for the specific materials. Corrections necessitated by variations in the moisture content of the component materials or for other similar reasons shall be made as directed, based upon laboratory determinations.

The contractor shall handle and measure the fine aggregate and the two sizes of coarse aggregate separately. No batch shall be run requiring fractional bags of cement. Cement shall be measured by the bag as packed by the manufacturer. Water shall be measured either by volume or by weight. The allowable error in accuracy of water measuring equipment on the mixer shall not be more than 2 percent. The equipment should preferably include an auxiliary tank from which the measuring tank shall be filled, and in any case shall be so arranged that the accuracy of measurement will not be affected by variations in pressure in the water supply line.

(D) Equipment for Weighing Aggregates. The weighing methods shall be approved by the engineer prior to the beginning of the batching operations, and the weighing equipment shall conform to the following requirements:

The capacity of the weighing equipment shall be adequate to permit the required weighing of materials without delaying the production of the mixer. The scales, that is the balance or weighing mechanism, shall be of the beam or springless dial type and shall be the product of an established manufacturer. Unless the scale is equipped with a multiple weigh beam which permits the weighing of more than one kind of material on the same scale without changing the settings on the weigh beams, separate scale units shall be furnished for each kind of material to be weighed. Scales shall be so designed and built that they may be maintained within a maximum tolerance of 1 per cent of the net load being weighed.

The value of the minimum graduation shall not be greater than 2 pounds for scales of 2,000-pound and less capacity, or greater than 5 pounds for scales over 2,000-pound capacity.

Scales of the suspended hopper type shall be equipped with a telltale dial or similar device for indicating to the scale operator that the required load in the weighing container is being approached. Such device shall indicate at least the last 50 pounds of load.

Each scale's installation shall be provided with standard 50-pound test weights which shall be subject to such tests as the engineer deems necessary in order to determine their accuracy. The minimum number of test weights required shall be of a weight equivalent to 10 per cent of the net load capacity of the scales to the nearest greater 50 pounds, but in no case less than two test weights.

(E) Consistency. Concrete shall have a consistency such that it will be workable in the required position. It shall be of such consistency that it will flow around reinforcing steel but individual particles of the coarse aggregate when isolated shall show a coating of mortar containing its proportionate amount of sand. The consistency of concrete shall be gauged by the ability of the equipment to properly place it and not by the difficulty in mixing or transporting. In all cases the amount of water used shall be the minimum necessary to secure the de-

sired workability of the concrete, within the ranges of slump specified. The quantity of the mixing water shall be determined by the engineer in accordance with Article 46.03 and shall not be varied without his consent.

(F) Mixing. (1) Mixing at Site. The concrete shall be mixed only in such quantities as are required for immediate use. No retempering of the concrete will be allowed. Aggregates or bags of cement containing lumps or crusts of hardened material shall not be used.

Concrete shall be thoroughly mixed in a batch mixer of approved type and capacity for a period of not less than 1.5 minutes after all materials, including water, are in the drum. During such period, the drum shall be operated at drum speeds specified by the mixer manufacturer and shown on his nameplate on the machine. The entire contents of the mixer shall be removed from the drum before materials for the succeeding batch are placed therein and the mixer preferably shall be equipped with mechanical means for preventing the addition of aggregates after mixing has commenced.

The mixer shall be equipped with an approved timing device which will automatically lock the discharging device so as to prevent the emptying of the mixer until the materials have been mixed the minimum specified time. No mixer shall be operated above its rated capacity and no mixer shall be used which has a rated capacity of less than one-bag batch.

The first batch of concrete material placed in the mixer shall contain an additional quantity of sand, cement and water sufficient to coat the inside surface of the drum without diminishing the mortar content of the mix. Upon the cessation of mixing for any considerable length of time, the mixer shall be thoroughly cleaned.

Hand mixing will not be permitted, except in case of emergency and under written permission from the engineer. When permitted, it shall be done only on water-tight platforms. The sand shall be spread evenly over the platform and the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of a uniform color, after which it shall be formed into a "crater" and water added in an amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is procured. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and returned at least 6 times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance. Hand mixed batches shall not exceed $\frac{1}{2}$ cubic yard in volume. Hand mixing will not be permitted for concrete to be placed under water.

(2) Ready Mixed. Materials for ready-mixed concrete shall

be handled, measured, and batched in compliance with the requirements for site-mixed concrete.

Plant capacity and transportation equipment shall be sufficient to insure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall be such as to provide for the proper handling, placing, and finishing of the concrete. The interval between batches shall not exceed twenty minutes. The methods of delivery and handling concrete shall be such as will facilitate placing with a minimum of rehandling and without damage to the structure of the concrete.

No mixed or agitated concrete shall be used which has remained in the drum of the truck agitator or truck mixer more than ten minutes without mechanical agitation.

The method and time of delivery shall be controlled by plant slips issued to the driver and signed by the engineer or inspector at the plant. This slip shall contain the name and location of the plant, the size and proportion of the batch, the time the vehicle left the plant, and the recording of the revolution counter. Upon arrival, the slip shall be delivered to the inspector or engineer at the site of The Work.

The concrete as delivered to the forms shall retain four to seven percent entrained-air as determined by AASHO T 121 or T 152.

(a) Central Plant Mixing. Concrete may be mixed at a central plant. When mixed at a central plant, the mixer and methods used shall be in accordance with the requirements of Part (F) (1), Mixing at Site, and those set forth below.

The minimum mixing time shall be 1.5 minutes.

Mixed concrete shall be transported from the central mixing plant to the site of The Work in agitator trucks of approved design. Unless otherwise permitted in writing, the agitator shall be a closed water-tight revolving drum. It shall be suitably mounted and shall be capable of transporting and discharging the concrete without segregation. The agitating speed of the drum shall be not less than two nor more than six revolutions per minute. The volume of mixed concrete permitted in the drum shall not exceed the manufacturer's rating nor exceed eighty percent of the gross volume of the drum.

Concrete transported in agitator trucks shall be discharged at the job and placed in its final position in the forms within one and one-half hours after the introduction of mixing water, except that when the temperature is 85°F. or above, the concrete shall be placed in its final position in the forms within one hour after the introduction of the mixing water.

(b) Truck Mixing. Concrete shall be mixed in a truck mixer of approved design. Truck mixing shall be in accordance with the following provisions:

Unless otherwise permitted in writing, the truck mixer shall be a closed, water-tight, revolving drum. It shall be suit-

ably mounted and shall be fitted with blades capable of combining all ingredients into a thoroughly mixed and uniform mass and of discharging the concrete without segregation. The mixing speed of the drum shall be not less than four nor more than fifteen revolutions per minute. The agitating speed of the drum shall be not less than two nor more than six revolutions per minute.

The volume of mixed concrete permitted in the drum of truck mixers shall not exceed the manufacturer's rating on the capacity plate nor fifty percent of the gross volume of the drum in the case of top-door-loading truck mixers nor fifty-seven and one-half ($57\frac{1}{2}$) percent in the case of end-loading truck mixers.

Each truck mixer shall be equipped with an approved device for registering the number of revolutions made by the drum during the interval between introduction of water into the drum and discharge of concrete from the mixer. The drum shall revolve continuously during this interval.

When truck mixers are used, a water-measuring device shall be provided to measure accurately the quantity of water for each batch. The device shall be mounted on the truck mixer or located at the point of taking on the water. The device shall permit ready access and ready determination of the amount of water used.

When wash water is used as a portion of the mixing water for the succeeding batch, it shall be accurately measured and taken into account in determining the amount of additional mixing water required. When wash water is carried on the truck mixer, it shall be carried in a compartment separate from that used for carrying or measuring the mixing water.

WATER INTRODUCED AT PLANT. When water, cement and aggregates are introduced into a truck-mixer drum at the loading plant, the drum shall revolve continuously until the concrete is discharged therefrom. Mixing shall commence immediately after the introduction of water and shall continue for at least fifty revolutions of the drum at mixing speed. Not more than one-hundred revolutions of the drum shall be at a speed in excess of six revolutions per minute. Any other revolutions shall be at agitating speed of not less than two nor more than six revolutions per minute.

The concrete shall be discharged at the job and placed in its final position in the forms within one and one-half hours after the introduction of the mixing water, except that when the temperature is 85°F. or above, the concrete shall be placed in its final position in the forms within one hour after the introduction of the mixing water.

WATER INTRODUCED IN TRANSIT. The interval between the charging of the mixer drum with cement and aggregates and the introduction of the mixing water shall not exceed thirty minutes.

Mixing shall commence immediately after the introduction of the mixing water and shall continue at mixing speed for at least fifty revolutions of the drum. Not more than one-hundred revolutions of the drum shall be at a speed in excess of six r.p.m. Any other revolutions shall be at agitating speed of not less than two nor more than six revolutions per minute.

The time interval between introduction of water and final discharge of concrete from the truck mixer shall be as specified for "Water Introduced at Plant."

WATER INTRODUCED AT SITE. When water is to be introduced into the truck-mixed drum at the site of the concrete construction, the requirements above for "Water Introduced in Transit" shall govern.

(c) Partial Mixing at the Central Plant. Concrete may be partially mixed by central plant mixing for the purpose of shrinking the batch and the mixing completed by truck mixing.

The central plant mixing shall be in accordance with the requirements of Part (F)(1), (Article 46.05), "Mixing at Site" except that the mixing time at the central plant may be reduced to thirty seconds. The truck mixing shall be in accordance with the requirements of Part (F)(2)(b), (Article 46.05), "Water Introduced at Plant" save that the volume of mixed concrete allowed in the drum shall not exceed sixty-six and two-thirds (66 $\frac{2}{3}$) percent of the gross volume of the drum.

(G) Placing Concrete. Concrete shall then be placed in the forms immediately after mixing and in no case shall concrete be used which does not reach its final position in the forms within the time stipulated under Part (F) above. The method of placing shall be such as to avoid segregation of the aggregates or displacement of reinforcement. During the placing of deck slab, curbs, and rail, the fresh concrete shall be protected from the direct rays of the sun and from the drying affects of the heat and wind.

Use of long chutes for conveying concrete from mixing plant to forms will not be permitted. Troughs, pipes or short chutes used as aids in placing concrete shall be arranged and used in such a manner that the ingredients of the concrete are not separated. Where steep slopes are required the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement. When pipes are used they shall be kept full of concrete and have their lower ends kept buried in fresh concrete in the same manner that a tremie is used. All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the concrete in place. Open troughs and chutes shall be either of metal or metal lined and shall extend as nearly as possible to the point of deposit. When the discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

Dropping the concrete a distance of more than five feet or depositing a large quantity at any point and running or working it along the forms will not be permitted.

Placing of concrete shall be so regulated that the pressures caused by the wet concrete shall not exceed those used in the design of the forms.

Special care shall be taken to fill each part of the forms by depositing concrete directly as near final position as possible, to work the coarser aggregates back from the face and to force the concrete under and around the reinforcement bars without displacing them. The placing of concrete shall be done in such manner that the steel reinforcing is not coated with cement before its final embedment. In depositing concrete around steel shapes and closely spaced reinforcing bars the concrete shall be deposited on one side of the steel and worked until it flushes under the steel to the opposite side before any concrete is placed on the opposite side or over the steel. After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting reinforcement.

Concrete shall be compacted by continuous working with suitable tools or suitable vibrating equipment in a manner acceptable to the engineer. All concrete, except that placed in handrails or curbs when poured as separate units, or that which is placed under water, shall be compacted by working with an internal vibratory tamper operating with a vibrating frequency of not less than forty-five hundred per minute, except that on structures involving less than fifty cubic yards, the engineer may, at his discretion, waive this requirement. The vibrating element shall not be attached to, nor shall it be held against, the forms, reinforcing steel, or any other embedded fixtures around which the concrete is being placed. The vibrator shall be so operated that it will not penetrate through the fresh concrete into any that is partially hardened. Vibration shall be supplemented by such spading as is necessary to insure smooth surfaces and dense concrete, along form surfaces and in locations impossible to reach with vibrators.

Concrete shall be placed in each section of The Work in a continuous operation working day and night, if necessary, to avoid stoppage planes. It shall be deposited in horizontal layers when practicable, placing thin layers at first that can be thoroughly worked into intimate contact with the concrete beneath. The depth of layers used shall be such that the succeeding layer will be placed before the previous layer has attained initial set. Each layer shall be compacted in a manner that will break up and obliterate any tendency to form a plane of separation between the layers. If it is necessary, by reason of an emergency, to stop placing concrete before any section is completed, bulkheads shall be placed as the engineer may direct. Any place where the placing of concrete is discontinued for a sufficient time to allow the concrete to take initial set

shall be deemed a construction joint and treated as hereinafter described under "Construction Joints."

Horizontal layers so located as to produce a construction joint at a location wherein a "feather edge" might be produced in the succeeding layer, shall be formed by inset work so that the succeeding layer will end in a body of concrete having a thickness of not less than six inches.

In no case shall the work on any section or layer be stopped or temporarily discontinued within eighteen inches below the top of any face, unless the details of the work provide for a coping having a thickness of less than eighteen inches, in which case, at the option of the engineer, the construction joint may be made at the under side of the coping.

The method and manner of placing concrete shall be so regulated as to place all construction joints across regions of low shearing stress and in such locations as will be hidden from view to the greatest possible extent. The method and sequence of placing concrete for the various types of concrete bridge construction shall be as specified below for the particular type of construction involved.

Concrete in girder haunches less than three feet in height shall be placed at the same time as that in the girder stem and the column or abutment tops shall be cut back to form seats for the haunches. Whenever any haunch or fillet has a vertical height of three feet or more, the abutment (or columns), the haunch and the girder shall be poured in three successive stages; first, up to the lower edge of the haunch; second, to the lower side of the girder. and third, to completion.

The operation of placing concrete in floor slabs shall be continuous between construction and/or expansion joints. Joints shall be vertical, at right angles to the axis of the roadway, and over the center of a flcorbeam or other support provided in the design.

The floors and girders of through girder superstructures shall be placed in one continuous operation unless otherwise specified, in which case special shear anchorage shall be provided to insure monolithic action between girder and floor.

PLACING CONCRETE IN REINFORCED CONCRETE SLAB AND GIRDER BRIDGES. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers. Concrete in slab spans shall be placed in one continuous operation for each span.

PLACING CONCRETE IN BEAMS. Each beam, between the limits shown on the plans or as directed, shall be cast in one continuous operation. The top of the concrete shall be kept level and it shall be placed in layers, the thickness of which shall be proportioned to the rate of delivery of the concrete to the forms so that there will be no planes of initial set in any part of the unit. All keyways, seats for secondary beams, dowels

and bars that connect the beams with other units of The Work shall be in place before the placing of concrete is commenced.

Concrete in T-beam or deck girder spans shall be placed either in one continuous operation or in two separate operations, each of which shall be continuous; first, to the top of the girder stems and, second, to completion. In the latter case, the bond between stem and slab shall be positive and mechanical and shall be secured by means of suitable shear keys with or without dowels in the top of girder stem. The size and location of these keys and dowels shall be computed. In general, suitable keys may be formed by the use of timber blocks approximately two inches by four inches in cross section and having a length four inches less than the width of the girder stem. These key blocks shall be spaced along the girder stem as required but the spacing shall be not greater than one foot center to center. The blocks shall be beveled and oiled in such manner as to insure their ready removal.

PLACING CONCRETE IN CONCRETE VIADUCTS. Concrete in columns shall be placed in one continuous operation, unless otherwise directed. Columns shall be allowed to set at least twelve hours before the caps are placed. No concrete shall be placed in the superstructure until column forms have been stripped sufficiently to determine character of concrete in the columns. The load of the superstructure shall not be allowed to come upon the bents until they have been in place at least fourteen days, unless otherwise permitted.

PLACING CONCRETE IN CONCRETE ARCHES. The concrete in arch rings shall be placed in such manner as to load the centering symmetrically. The centering shall be weighted if necessary to prevent distortion. Arch rings shall be divided into sections of such size that when working simultaneously at points symmetrically located about the crown the sections can be cast in one continuous operation without permitting the formation of planes of initial set. The sections shall be bonded together by suitable keys or dowels. Arch rings may be cast in a single continuous operation when specified on the plans or permitted by the engineer. The arrangement of sections shall be such as to avoid the creation of initial stresses in the reinforcement. Adequate struts shall be provided to resist any unbalanced thrusts to piers in structures composed of more than one span. The size, arrangement, and sequence of placing concrete for sections of all arches shall be subject to the approval of the engineer.

(H) Depositing Concrete Under Water. Concrete shall not be exposed to the action of water before setting, or deposited in water, except with the approval of the engineer and under his immediate supervision. When concrete is so deposited, the method and manner of placing shall be as hereinafter designated.

All concrete deposited under water shall be mixed in the proportions designated for Class "S" concrete.

Concrete deposited under water shall be carefully placed in a compact mass in its final position by means of a tremie or other approved methods and shall not be disturbed after being deposited. Special care shall be exercised to maintain still water at the point of deposit. No concrete shall be placed in running water and all form work designed to retain concrete under water shall be water-tight. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Each seal shall be placed in one continuous operation.

When a tremie is used it shall consist of a tube having a diameter of not less than ten inches, constructed in sections having flanged couplings fitted with gaskets. The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire top of the work and to permit it being rapidly lowered when necessary to choke off or retard the flow.

The discharge end shall be entirely sealed at all times and the tremie tube kept full to the bottom of the hopper. When a batch is dumped into the hopper the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow is then stopped by lowering the tremie. The flow shall be continuous and in no case shall be interrupted until the work is completed.

(I) Construction Joints. When the work of placing concrete is delayed until the concrete has taken initial set, the point of stopping shall be deemed a construction joint. The location of construction joints shall be planned in advance and shall be subject to approval by the engineer. The placing of concrete shall be carried continuously from joint to joint. These joints shall then be perpendicular to the principal lines of stress and in general be located at points of minimum shear.

At all horizontal construction joints and at other location, when directed, a gage strip not less than two inches thick shall be placed inside the forms along all exposed faces to give the joints a straight line and eliminate wedge shaped particles of concrete that might chip off. In placing concrete up to construction joints the forms shall be "over filled" at least one inch and all excess material removed.

In joining fresh concrete to concrete that has already set, the forms shall be drawn tight against the face of the set concrete and all gage strips and key forms removed. The surface of the set concrete to be contacted shall then be cut over with suitable tools to remove all laitance, loose and foreign material. This surface shall then be washed and scrubbed with wire brooms, drenched with water until saturated and kept saturated until the new concrete is placed. Immediately prior to placing new concrete, the old surface shall be thoroughly coated with a very thin coating of neat cement mortar.

In order to bond successive courses, suitable keys shall be formed at the top of the upper layer of each day's work and at other levels where work is interrupted. These keys shall be

formed by the insertion and subsequent removal of beveled wood strips which shall be thoroughly saturated with water prior to insertion. Rough stone or steel dowels may, at the discretion of the engineer, be used in lieu of keys. All construction joints shall be keyed or doweled as shown on the plans or as directed.

Sliding joints shall be true planes paralleled to the direction of movement. Where sliding joints are to be provided at the ends of slabs, girders or beams, or between walls, etc., the surface of the supporting concrete shall be given a smooth finish and covered with two layers of three-ply roofing felt to separate the concrete.

Unless otherwise shown on the plans, expansion joints shall be filled with an approved premolded expansion joint filler. The thickness of the joints shall be one-fourth inch where the length of the moving concrete is twenty feet or less, one-half inch for lengths twenty-one to thirty-six feet, and three-fourths inch for lengths of thirty-seven to fifty feet unless otherwise shown on the plans. The joint filler shall be cut to the same shape as the area to be covered with one-fourth inch smaller along all surfaces that will be exposed in the finished work. It shall be firmly fixed against the surface of the concrete already in place in such manner that it will not be displaced when the concrete is deposited against it. Where necessary to use more than one piece to cover any surface, the joint between the separate pieces shall be covered with a layer of two-ply roofing felt, one side of which shall be covered with hot asphalt to insure proper retention. The one-fourth inch space along the edges at exposed faces shall be filled with wooden strips of the same thickness as the joint material. These wooden strips shall be saturated with oil and have sufficient "draft" to make them readily removable after the concrete is placed. Immediately after the forms are removed the expansion joints shall be carefully inspected. Any concrete or mortar that has sealed across the joint shall be neatly cut and removed.

Special water-tight and flashed joints shall be constructed as shown on the plans.

(J) Cold Weather Concreting. During freezing weather provision shall be made for heating the water, aggregates and concrete and the concrete shall be thoroughly protected until set. When concrete operation are carried on during freezing weather the aggregates shall be heated by either steam or dry heat to a temperature of not less than 70° F. and not more than 150° F. The water shall be heated to a temperature between 130° F. and 150° F. The temperature of the mixed concrete shall be not less than 65° F. and not more than 85° F. at the time of placing it in the forms. Neither salt nor chemical admixtures shall be added to the concrete to prevent freezing.

The contractor shall assume all risk in connection with placing concrete in cold weather, and placing the concrete during freezing weather shall in no way relieve the contractor

of responsibility for proper results. Should concrete placed under these conditions prove unsatisfactory it shall be removed and replaced at the contractor's expense.

When the low temperatures are expected to drop to or below freezing or the high temperatures of the day are expected to remain below 40°F. the contractor shall furnish sufficient canvas and a framework or other type of housing to enclose and protect the structure in such a way that the air surrounding the fresh concrete can be kept at a temperature not less than 60°F. for a period of seven days after the concrete is placed.

All heating of the air surrounding the concrete shall preferably be done with steam or hot water. When any other type of heating is applied, it will be necessary that Article 46.05 (K) Curing Concrete is complied with. At the close of the curing period, the heat may be reduced to such an extent that the temperature inside the housing shall not decrease faster than 20° per day until such time that the temperature inside the housing is the same as that outside. A sudden change of temperature shall be prevented. The seven day curing period is based on the use of standard Portland cement and a curing temperature of not less than 60°F.

In case of failure of the contractor to comply with any of the above provisions for curing and heating of concrete, the engineer will immediately notify the contractor to comply with the required provisions as specified above. In the event the contractor fails to remedy the unsatisfactory condition within one hour after issuance of such notice, the engineer will immediately proceed with the contractor's forces and equipment or any other available forces and equipment to cure and heat the concrete, as specified above, and the entire cost to the State of this work will be deducted from any money due the contractor.

(K) Curing Concrete. Concrete surfaces exposed to conditions causing premature drying shall be protected by covering as soon as possible with canvas, burlap, sand or other satisfactory material and kept moist; or if the surfaces are not covered, they shall be kept moist by flushing or sprinkling. Curing shall continue for a period of not less than seven days after placing the concrete. Other precautions to insure the development of strength shall be taken by the contractor as directed.

Forms and existing concrete shall be kept continuously wet for a period of not less than one hour before any concrete is placed therein and shall be kept wet until covered with concrete except that adequately oiled forms shall be thoroughly washed with a water spray immediately before the placing of concrete therein.

All forms for vertical surfaces shall be covered with burlap or an approved equivalent immediately upon completion of the

placing of the concrete, and the cover material used shall be kept wet until the forms are removed.

Unless otherwise approved by the engineer, the curing of concrete shall be accomplished by either water curing or membrane curing as follows:

(1) Water Curing. All top surfaces of concrete shall be kept moist after finishing with a fine water spray until such time as the concrete has set sufficiently to permit it to be covered with burlap or an approved equivalent. The temperature of the water used shall be as near as possible to that of the fresh concrete. The burlap shall be placed as close behind the finishers as possible without marring the finished surface and shall be kept wet for the entire curing period or in the case of concrete floors until removed.

As soon as practicable after the concrete floor has been placed, the burlap covering shall be removed, and the entire floor surface shall be covered with at least one and one-half inches of moist sand, which shall be kept wetted continuously for the curing period.

Forms shall be removed from all vertical surfaces as soon as the concrete has set sufficiently to permit their removal. The contractor shall then remove all surface irregularities and shall repair all depressions, voids, or holes, including holes formed by trapped air, all in accordance with Part (L) of this article. The removal of forms and the repair of surface irregularities shall be accomplished without interfering with any of the curing requirements. As soon as the vertical forms have been removed and the surface irregularities repaired, the concrete shall be completely covered with burlap or equivalent material, which shall be kept continuously wet for the balance of the curing period.

(2) Impervious Membrane Curing. The membrane curing compound shall comply with AASHO M 148 and shall be delivered to the job in the manufacturer's original container, clearly labeled to show the name of the manufacturer and the contents. The clear curing compound shall be sufficiently transparent and free from permanent color to result in no pronounced change in color from that of the natural concrete. The compound shall, however, contain a dye of color strength sufficient to render the film distinctly visible on the concrete for a period of at least four hours after application.

The material shall be ready for use as shipped by the manufacturer and no diluting will be permitted. At least one pint sample of the membrane curing material shall be taken from each shipment or load, and no material shall be used prior to written approval. The sealing solution shall be applied under pressure with a spray nozzle in such a manner as to cover the entire exposed surface thoroughly and completely with a uniform film at the rate of not less than one gallon per one-hundred-fifty square feet of concrete surface. Sufficient

pressure shall be maintained in the spray machine to force the material to leave the nozzle in the form of a fine mist. All concrete surface shall be kept moist with a fine water spray or with wetted burlap until such time as the sealing compound is applied. The applicator shall keep close up to the finishers of the top surfaces of concrete at all times and spray all concrete immediately after the finishing operations are completed to the satisfaction of the engineer. No traffic of any sort, pedestrian or vehicular, will be permitted on the top surface of any concrete that has been sealed, for a period of not less than seven days after placing, unless first covered with a layer of fine sand not less than one inch thick. The sand shall not be placed for at least eight hours after the final application of the sealing compound.

When concrete is cast in forms, such as walls, beams, columns, etc., it shall be kept continuously wet while in the forms, and during the stripping and surface repair operations. Forms shall be removed from all vertical surfaces as soon as the concrete has set sufficiently to permit their removal. The contractor shall then remove all surface irregularities and shall repair all depressions, voids, or holes, including holes formed by trapped air, all in accordance with the provisions of Part (L) of this article. As soon as the contractor has removed all surface irregularities and repaired all depressions, voids, or holes, including those formed by trapped air, to the satisfaction of the engineer, the sealing compound shall be applied immediately before the surface has had an opportunity to dry out.

(L) Removal of Forms and Falsework. In order to facilitate finishing, forms on ornamental work, railings, parapets and exposed vertical surfaces shall be removed in not less than twelve or more than forty-eight hours, depending upon weather conditions. Forms under slabs, beams, girders and arches shall remain in place at least fourteen days in warm weather and in cold weather at the discretion of the engineer, except that forms for slabs having a span length of less than ten feet may be removed at the end of seven days. Forms shall always be removed from columns before removing shoring from beneath beams and girders in order to determine the conditions of concrete in the columns.

No forms whatever shall be removed at any time without the consent of the engineer. Such consent shall not relieve the contractor of responsibility for the safety of the work. Blocks and bracing shall be removed with the forms and in no case shall any portion of the wood forms be left in the concrete. Lips of mortar and all irregularities caused by form joints shall be removed. The presence of honeycomb areas may be considered sufficient cause for rejection of the structure, and upon written notice the contractor shall remove and rebuild the structure in part or in whole as specified, at his own expense.

As soon as the forms are removed, all projecting wires, tie bolts or other metal devices used for holding the forms in place and which pass through the body of the concrete shall be cut

back as specified under Part (B) of this article, and the holes or depressions thus made, and all other holes, depressions and small voids which show upon the removal of the forms, shall be repaired as follows: All coarse or broken material shall be chipped away until a dense uniform surface of concrete exposing solid coarse aggregate is obtained. Feather edges shall be cut away to form faces perpendicular to the surface being patched. All surfaces of the cavity shall be thoroughly saturated with water, after which a thin layer of neat cement mortar shall be applied. The cavity shall then be filled with a thick mortar mixed in the same proportion as that which was used in the body of the work and of the same temperature as the surface against which it is to be placed. The cement used in the patching mortar shall be a blend of Portland cement and white Portland cement properly proportioned so that the final color of the cured mortar will be the same as the color of the surrounding concrete. The mortar shall be thoroughly tamped into place and the surface floated with a wood float before initial set takes place. The patch shall then be cured as set forth for the concrete in Part (K) of this article.

For patching large or deep areas, coarse aggregate shall be added to the patching material and special precautions shall be taken to insure a dense, well bonded and properly cured patch, all as required by the engineer.

Falsework shall not be removed at any time without the consent of the engineer. Such consent shall not relieve the contractor of responsibility for the safety of the work. Falsework shall remain in place after concreting is completed at least fourteen (14) days in warm weather and in cold weather at the discretion of the engineer.

Falsework and centering for arches shall not be struck until the fill back of the abutments has been placed up to the spring line. Falsework for rigid frame structures shall not be removed until the fill has been placed back of the vertical legs.

All falsework piling shall be pulled or cut off one foot below finished ground line where conditions will permit. If conditions are not favorable for pulling or cutting off the piles as stated above, the piles shall be either broken or shot off at the stream bed, unless otherwise provided by the engineer.

(M) Finishing Concrete. All concrete surfaces exposed in the completed work shall comply with the requirements of Ordinary Finish as specified in Part (M) (1), except that the concrete deck slab and the concrete curb and sidewalk surfaces shall comply with the requirements of Parts (M) (2) and (M) (3), respectively, unless otherwise provided or indicated on the plans or in the special provisions.

(1) Ordinary Finish. An Ordinary Finish is defined as the surface left by the removal of the forms with all holes left by form ties filled and all defects repaired. The surface shall be true and even, free from stone pockets, depressions or projections beyond the surface. All surfaces which cannot be repaired to the satisfaction of the engineer shall be given a "Rubbed Finish".

(2) Concrete Floors. Concrete floors shall be struck off with a template immediately after pouring to provide the proper crown and shall be finished to a smooth even surface by means of both longitudinal and transverse wooden floats, or other suitable means. The finished surface shall not show a variation of over one-eighth inch in ten feet using a ten foot straightedge placed parallel to the centerline of roadway. When a transversely-broomed finish is used, the allowable variations noted herein shall be independent of the depth of the broom marks. No variations will be permitted that will tend to prevent complete drainage on all parts of the deck. The surface shall be corrected by grinding off the high spots, or other approved method, as may be required in order to conform to these limits. An edging tool shall be used at expansion joints not armored.

The concrete in bridge seats and tops of walls shall be brought flush with the finished top surface, struck off with a straightedge and floated.

(3) Curbs and Sidewalk Surfaces. Concrete curbs and sidewalks shall be finished in true surfaces having the lines and grades shown on the plans. Concrete shall be worked until the coarse aggregate is forced down into the body of the concrete so that no coarse aggregate is exposed. The surface shall then be floated with a wooden float to a smooth and uniform surface. When the concrete in the curb or sidewalk has hardened sufficiently, the surface shall be given a broom finish. The broom shall be of an approved type. The strokes shall be square across the curb or sidewalk from edge to edge with adjacent strokes overlapped and shall be made by drawing the broom without tearing the concrete, but so as to produce regular corrugations not over one-eighth inch in depth.

(4) Rubbed Finish. When the concrete has hardened before being rubbed the surface shall be thoroughly saturated with water and rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in the proportions used in the concrete being rubbed. When forms are removed while the concrete is still green the surface shall be wetted and rubbed with a wooden float. If permitted by the engineer, a thin mortar proportioned as outlined above may be used in the rubbing.

Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled and a uniform surface has been obtained. The paste produced by this rubbing shall be kept moist and allowed to set for at least

five days. The surface shall then be smoothed by rubbing with a fine carbarundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color. After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks.

(5) Special Tooled Finish. Special tooled finish shall be produced with a bush-hammer, a pick, a crandall or other tool approved for this purpose. Air tools, preferably, shall be used. No tooling shall be done until the concrete has set for at least fourteen days and as much longer as may be necessary to prevent the aggregate particles from being "picked" out of the surface. The finished surface shall show a grouping of broken aggregate particles in a matrix of mortar, each aggregate particle being in slight relief.

(N) Drainage and Weep Holes. Drainage and weep holes shall be constructed in the manner and where indicated on the plans or directed by the engineer. Drains and weep holes in the face of the abutments shall be connected with the roadway drains wherever indicated on the plans. Ports or vents for equalizing hydrostatic pressure shall be placed below low water. Weep holes shall be placed at the elevations shown or directed.

Forms for weep holes through concrete may be clay pipe, concrete drain pipe, or wooden boxes. If wooden forms are used they shall be removed after the concrete is placed. Where weep holes pass through stone masonry the outlet through the masonry shall be rectangular in shape, from two to three inches in width and from six to eight inches in height. Drain pipes embedded in concrete shall be standard light weight cast-iron water pipe or wrought iron pipe.

No direct compensation will be allowed for drainage and weep holes and incidental work in connection therewith. The cost shall be considered as included in the unit prices bid for the various classes of concrete. No deduction will be made in the volume of concrete or masonry for the space occupied by drains and weep holes.

(O) Pipes, Conduits and Ducts. Pipes, conduits and ducts which are to be encased in the concrete, shall be installed by the contractor as the concrete is being placed. They shall be rigidly held against displacement during the placing of the concrete.

No direct compensation will be allowed for furnishing and installing all pipes and conduits shown on the plans. The cost of furnishing, installing and incidental work in connection therewith shall be considered as included in the unit prices bid for the various classes of concrete. No deduction will be made in the volume of concrete for the space occupied by pipes, conduits and ducts.

(P) Defective Work. Any defective work discovered shall be removed immediately and renewed. If the surface of the concrete is bulged, uneven, or shows honeycombing which, in the opinion of the engineer, cannot be repaired satisfactorily, the entire section shall be removed and renewed. No compensation will be allowed for this work.

(Q) Class "F" Concrete. Concrete shall be thoroughly mixed in such a manner as to positively insure a uniform distribution of the materials throughout the mass. Batches shall be proportioned on the basis of integral sacks of cement.

Concrete shall be mixed only in such quantities as are required for immediate use and shall be used while fresh before initial set has taken place. Any concrete in which initial set has begun shall be wasted and not used in The Work and in no case will retempering of concrete be allowed.

Concrete shall be thoroughly tamped into the forms, or into the cavity in which it will be used, and shall be well spaded and consolidated around fittings and embedded items. All reinforcement and other embedded items shall be accurately placed as shown on the plans and shall be firmly held in position during concreting. All such material shall be thoroughly clean and free from coating, rust, scale, oil or any foreign matter.

Holes shall be thoroughly wet before pouring concrete. Exposed surfaces of concrete shall be protected from premature drying by means satisfactory to the engineer. The surface of finished concrete around posts shall be crowned to shed water.

46.06 PREFORMED EXPANSION JOINT FILLERS FOR CONCRETE. Preformed expansion joint fillers shall comply with AASHO M 153 and, unless otherwise indicated on the plans, the contractor shall furnish material conforming to Type I or Type II.

46.07 METHOD OF MEASUREMENT. The yardage to be paid for shall be the number of cubic yards of concrete of the several classes, complete in place and accepted. In computing the concrete yardage for payment, the dimensions used shall be those shown on plans or ordered in writing by the engineer. The quantity of concrete involved in fillets, scorings and chamfers two square inches or less in cross-sectional area shall be neglected. No deduction shall be made for the volume of concrete displaced by reinforcing steel, expansion joint material, drainage and weep holes, or pipes, conduits and ducts embedded in concrete. Deduction shall be made for the volume of timber piles, concrete piles, or structural steel, including steel piling but not including expansion joint material, encased in concrete. The volume of timber piles encased in concrete shall be assumed as 0.8 cubic foot per linear foot of pile. No measurements or other allowances will be made for forms, falsework, coffer-dams, pumping, bracing, etc.

There will be no measurement in the case of a lump sum bid.

The yardage shall not include any yardage of concrete contained in any other items when the said other item provides that its pay name be compensation for any concrete involved.

Class "F" concrete will not be measured for payment.

46.08 BASIS OF PAYMENT. The yardage determined as provided above, shall be paid for at the contract unit price bid per cubic yard for Class 'A', Class 'AD', Class 'DD', or Class 'S' Concrete as the case may be, which price and payment shall be full compensation for the concrete, for all materials, including expansion joint filler, water-stops, weep holes, pipes and conduits indicated on the plans, and for installation of all joints, weep holes, drains, pipes and conduits and for all timber bumpers, forms, falsework, placing and finishing, and for all labor, equipment, tools and incidentals necessary to complete the item, but shall not constitute payment for reinforcing steel, which will be paid for as a separate item.

If the item, or items, was bid on a lump sum basis then payment shall be made accordingly under the same general provisions cited above.

Class "F" Concrete shall not be measured for direct payment. Performance of this work is not payable directly, but shall be considered as a subsidiary obligation of the contractor, covered under the contract unit price for the individual work involved. The term "Class 'F' Concrete" shall be so interpreted as to include all materials, forms, steel, labor and any other costs involved in the completion of the item.

Class "AP" concrete will be paid for under Section 39.

SECTION 47

REINFORCING STEEL

47.01 DESCRIPTION. "Reinforcing Steel" shall consist of furnishing and placing reinforcing steel or wire fabric of the quality, type and size designated, in conformity with the plans, or as ordered in writing by the engineer, and in accordance with this specification. The use of cold twisted bars will not be permitted. Wire fabric shall be used only when specified and shall be of the type shown on the plans and approved by the engineer.

47.02 MATERIAL. Reinforcing steel shall conform to ASTM A 15, Intermediate grade, unless otherwise specified. All bars shall be of the deformed type conforming to AASHO M 137, unless otherwise specified.

Where purchased from warehouse in small lots, reinforcing steel may, at the direction of the engineer, be accepted subject to the bending test.

The test specimen shall bend cold around a pin without cracking on the outside of the bent portion in accordance with Table A:

TABLE A — BEND TEST REQUIREMENTS

Thickness or Diameter of Bars	Type of Bar Deformed Bars
Under No. 6 (nominal diameter $\frac{3}{4}$ "")	180 degrees $d = 6t$
No. 6 or over	90 degrees $d = 6t$

d = the diameter of pin about which specimen is bent.

t = the thickness or diameter of the specimen.

Wire and wire fabric, when used for reinforcement in concrete, shall conform to AASHO M 32 and AASHO M 55, respectively. The type of fabric shall be approved by the engineer.

47.03 PROTECTION OF MATERIAL. Steel reinforcement shall be protected at all times from injury. When placed in The Work, it shall be free from dirt, detrimental scale, paint, oil or other foreign substance. However, when steel has, on its sur-

face, detrimental rust, loose scale and dust which is easily removable, it may be cleaned by a satisfactory method, if approved by the engineer.

47.04 FABRICATION. Bent bar reinforcement shall be cold bent to the shapes shown on the plans, and unless otherwise provided on the plans or by authorization, bends shall be made in accordance with the following requirements:

Stirrups and tie bars shall be bent around a pin having a diameter not less than two times the minimum thickness of the bar. Bends for other bars shall be made around a pin having a diameter not less than six times the minimum thickness except for bars larger than one inch, in which case the bends shall be made around a pin of eight bar diameters.

Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the Code of Standard Practice of the Concrete Reinforcement Steel Institute.

When bar-bending diagrams are not shown on the contract plans, detail plans showing the bending of reinforcing bars shall be submitted to the engineer for approval.

47.05 PLACING AND FASTENING. All steel reinforcement shall be accurately placed in the positions shown on the plans and firmly held during the placing and setting of the concrete. Bars shall be tied at all intersections except where spacing is less than one foot in each direction when alternate intersections shall be tied.

Distances from the forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports. Blocks for holding reinforcement from contact with the forms shall be precast mortar blocks of approved shape and dimensions or approved metal chairs. Layers of bars shall be separated by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe and wooden blocks shall not be permitted. Reinforcement in any member shall be placed and then inspected and approved by the engineer before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and removal required.

If fabric reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

47.06 SPLICING REINFORCEMENT. All reinforcement shall be furnished in the full lengths indicated on the plans. Splicing of bars, except where shown on the plans, will not be permitted without written approval. Splices shall be staggered as far as possible.

Unless otherwise shown on the plans, bars in the bottom of beams and girders, and in walls, columns and haunches shall be lapped twenty diameters and bars near the top of beams and girders having more than twelve inches of concrete under the bars shall be lapped thirty-five diameters, to make the splice.

47.07 METHOD OF MEASUREMENT. The poundage to be paid for shall be the calculated theoretical weight of the steel as shown on the plans or as ordered in writing by the engineer, complete in place, and accepted. The weights of standard sizes of reinforcing bars, conforming to AASHO M 137, shall be computed in accordance with the following table:

No. 3 Bars	.376 Lbs. Per Foot
No. 4 Bars	.668 Lbs. Per Foot
No. 5 Bars	1.043 Lbs. Per Foot
No. 6 Bars	1.502 Lbs. Per Foot
No. 7 Bars	2.044 Lbs. Per Foot
No. 8 Bars	2.670 Lbs. Per Foot
No. 9 Bars	3.400 Lbs. Per Foot
No. 10 Bars	4.303 Lbs. Per Foot
No. 11 Bars	5.313 Lbs. Per Foot

If reinforcing bars, other than standard sizes, or wire fabric are required, the unit weight will be shown on the plans.

47.08 BASIS OF PAYMENT. The poundage, determined as provided above, shall be paid for at the contract unit price bid for reinforcing steel complete in place, which price shall be full compensation for The Work. No allowance will be made for the clips, wire, separators, or other material used for fastening or supporting the reinforcing steel in place.

SECTION 48

STRUCTURAL STEEL

48.01 DESCRIPTION. "Structural Steel" shall consist of furnishing, fabricating and erecting all structural steel shapes, plates, rivets and all other metal parts not included for payment under some other contract item, all erected in conformity with the plans or as directed in writing. Furnishing and fabricating shall include delivery of the shop painted materials to the site of The Work as shown on the plans, free of charge. Erecting shall include furnishing and applying field paint, unless otherwise specified.

48.02 MATERIAL. Structural steel, including eyebar, rivet steels, and special alloy steels, shall conform to ASTM Standard Specifications as designated in the following table. Unless otherwise specified on the plans or in the special provisions, structural carbon steel shall be used where structural steel is specified, and structural rivet steel for all rivets.

Type	A.S.T.M. Designation
Structural carbon and eyebar steel	A 7
Structural weldable steel	A 373
Structural rivet steel	A 141
High-strength structural rivet steel	A 195
Low-alloy structural steel	A 242
High strength structural steel, non-weldable	A 440
High strength structural steel, weldable	A 441
Structural carbon steel	A 36

Alloy steels shall be plainly marked at frequent intervals for identification. These marks shall be made during or immediately after rolling, shall be of such nature and spacing that they will be visible on practically all pieces during fabrication, and shall be visible after shop and field paints have been applied.

48.03 CONSTRUCTION METHODS. All structural steel shall be fabricated, erected and painted as set forth on the plans and as specified in Section 42.

48.04 MILL AND SHOP INSPECTION. **(A) Notice of Beginning of Work.** The contractor shall give the engineer ample notice of the beginning of work at the mill or in the shop, so that inspection may be provided. The term "mill" means any rolling mill or foundry where material for The Work is to be manufactured. No material shall be manufactured or work done in the shop before the engineer has been so notified.

(B) Facilities for Inspection. The contractor shall furnish facilities for the inspection of material and workmanship in the mill and shop, and the inspectors shall be allowed free access to the necessary parts of the work.

(C) Inspector's Authority. The inspector shall have the authority to reject any material or work which does not meet the requirements of the specifications. In case of dispute, the contractor may appeal to the engineer, whose decision shall be final.

(D) Mill Orders and Shipping Statements. The contractor shall furnish the engineer with as many copies of mill orders and shipping statements as he may direct. The weights of the individual members shall be shown on the statements.

(E) Facilities for Testing. The contractor shall furnish test specimens, as specified herein, without extra charge; also the labor, testing machines and tools necessary to make the specimens and full-size tests.

(F) Rejections. The acceptance of any material or finished members by the inspector shall not be a bar to their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the contractor.

48.05 METHOD OF MEASUREMENT. The poundage to be paid for shall be the number of pounds of structural steel of the type or types specified in the fabricated structure including field rivets, shipped, but not in excess of the number of field rivets specified under Article 42.06(P). The weight of erection bolts, field paint, boxes, crates and other containers used for packing and materials used for supporting members during transportation shall not be included.

The weights paid for shall be calculated on the basis of the following assumptions: **(A)** Unit weights, pounds per cubic foot;

Aluminum, cast or wrought	173.0
Bronze, cast	536.0
Copper-alloy	536.0
Copper sheet	558.0
Iron, cast	445.0
Iron, malleable	470.0
Iron, wrought	487.0
Lead, sheet	707.0
Steel, rolled, cast, copper bearing, silicon, nickel and stainless	490.0
Zinc	450.0

(B) The weights of rolled shapes and of plates up to and including thirty-six inches in width shall be computed on the basis of their nominal weights and dimensions as shown on the approved shop drawings. To the nominal weights of plates more than thirty-six inches in width, there shall be added one-half of the allowed percentage of overrun in weight as tabulated in ASTM A 6. The weight will be computed on the basis of rectangular dimensions for all plates and overall lengths for all structural shapes and with no deductions for copes, clips, sheared edges, punchings, borings, milling or planing, provided, however, that when parts can be economically cut in multiples from material of larger dimension, the calculated weight shall be taken as that of the material from which the parts can be cut.

(C) The weight of shop rivets shall be computed on the basis of reasonable average lengths, in accordance with the following table:

Rivets $\frac{1}{2}$ " in diameter	20 pounds per 100 rivets
Rivets $\frac{5}{8}$ " in diameter	30 pounds per 100 rivets
Rivets $\frac{3}{4}$ " in diameter	50 pounds per 100 rivets
Rivets $\frac{7}{8}$ " in diameter	100 pounds per 100 rivets
Rivets 1 $\frac{1}{8}$ " in diameter	150 pounds per 100 rivets
Rivets 1 $\frac{1}{2}$ " in diameter	250 pounds per 100 rivets
Rivets 1 $\frac{1}{4}$ " in diameter	325 pounds per 100 rivets

(D) Field rivets and bolts shall be paid for on the basis of their computed weight.

(E) To the computed weight of metals may be added 0.4 of 1 percent as an allowance for shop paint.

(F) The weight of weld metal shall be computed on the basis of the theoretical volume of the dimensions of the welds. To this weight shall be added fifty percent allowance for overrun.

(G) When any items specified under this section are bid on a lump sum basis, there will be no measurements or weight determinations.

48.06 BASIS OF PAYMENT. The poundage, determined as provided above, shall be paid for at the contract unit price per pound for structural steel of the type or types specified, which price and payment shall constitute full compensation for furnishing, fabricating, delivering, erecting ready for use, and painting all the steel and other metal, and for all labor, equipment, tools and incidentals necessary to complete the item.

When the items specified under this section are bid on a lump sum basis payment shall be made in that manner under the same general provisions cited above.

SECTION 49

BEARING AND EXPANSION PLATES AND ROCKERS

49.01 DESCRIPTION. "Bearing and Expansion Plates and Rockers", conforming to these specifications, of the sizes and dimensions shown on the plans, shall be furnished and placed as called for on the plans or as directed by the engineer.

49.02 MATERIAL. (A) Bronze bearing and expansion plates shall conform to ASTM B 22. Alloy "B" shall be furnished unless otherwise specified.

(B) Rolled copper-alloy bearing and expansion plates shall conform to ASTM B 100. Alloy No. 1 shall be furnished unless otherwise specified.

(C) Steel castings shall conform to AASHO M 103, mild to medium strength, carbon-steel castings for general application. All castings shall be Grade 65-35 unless otherwise specified.

49.03 CONSTRUCTION METHODS. Rockers and bearing plates shall be accurately set in correct position as shown on the plans and shall have uniform bearing over the total area.

Bearing plates shall be securely anchored to the concrete with bolts, set in the concrete, of the size and as shown on the plans. Sliding surfaces shall be planed parallel to the movement of the spans and polished and shall be thoroughly coated with graphite and grease just before being placed in position. Special care shall be taken to avoid placing concrete in such a manner as to interfere with their free action.

For a description of the method to be followed in setting bearing plates see Section 42. Rockers shall not be permanently set until after the bridge floor has been placed and then only after making due allowances for temperature.

49.04 METHOD OF MEASUREMENT. The weight of bronze bearing plates shall be computed from the dimensions as shown on the plans. The weight of bronze shall be assumed to be five-hundred-thirty-six (536) pounds per cubic foot.

The weight of castings shall be computed from the dimensions shown on the approved shop drawings, with an addition of five (5) per cent for fillets and overrun. The weight of cast steel shall be assumed to be four-hundred-ninety (490) pounds per cubic foot.

There will be no measurement of weights when the items specified by this section are bid on a lump sum basis.

49.05 BASIS OF PAYMENT. Payment will be made at the contract unit price bid per pound, or on a lump sum basis, for bronze bearing plates complete in place, which price will be full compensation for The Work.

Unless designated as a separate item in the proposal, payment for castings will be made at the unit price bid for structural steel in place. When designated as a separate item in the proposal, cast steel will be paid for at the unit price bid complete in place, whether by the pound or as a lump sum. Price and payment as outlined herein shall constitute full compensation for The Work.

SECTION 51

TREATED AND UNTREATED TIMBER

51.01 DESCRIPTION. "Treated and Untreated Timber" shall consist of structural timber of the grades, sizes, and dimensions specified, treated or untreated as called for, furnished in conformity with the plans and special provisions, or as ordered in writing by the engineer, and in accordance with this specification.

51.02 MATERIAL. (A) **General.** Unless otherwise specified, timber or lumber shall be standard sawn intermountain Douglas Fir (*Pseudotsuga taxifolia*), Western Larch (*Larix occidentalis*), Pacific Coast Douglas Fir (*Pseudotsuga taxifolia*), or any equivalent product. All lumber shall be furnished rough unless otherwise specified.

(B) **Grades.** Structural timber and lumber shall meet the requirements for the numerical stress values shown on the plans, or as may be otherwise specified, when graded by rules developed in accordance with ASTM D 245. Any commercial grading rules that will provide material of an equal or greater stress value may be used.

Only pieces consisting of sound wood, free from any form of decay, are acceptable, unless otherwise specified.

When untreated timber is specified, it shall show not less than eighty-five percent heartwood on the girth, measured at the point where the least amount of heartwood occurs on any girth. When treated timber is specified, there will be no heartwood requirements and the amount of sapwood will not be limited.

(C) **Incising.** All lumber treated with creosote, creosote coal-tar solution or five percent solution of pentachlorophenol, whose least dimension is two inches or over, shall be incised in a suitable power-driven machine. Lumber having a thickness of three inches and over shall be incised on all four sides. Lumber less than three inches thick shall be incised on the wide faces only, except where indicated on the drawings. The spacing and shape of the cutting teeth and the method of incising shall be such as to produce a uniform penetration. The depth of the incision shall be not less than the following:

Size	Minimum Depth of Incision
2 x 12	3/8 "
3 x 12	7/16"
4 x 12	1/2 "
8 x 10	9/16"
10 x 12	5/8 "
12 x 12	3/4 "

Intermediate sizes in proportion.

51.03 INSPECTION. Each shipment of lumber to be treated shall be inspected at the treating plant, both before and after treatment, by an inspector designated by the engineer. The inspector shall stamp the ends of each accepted piece with a suitable stamp which has been copyrighted by him, of which a true impression has been filed with The Commission. The inspector also shall file with The Commission an itemized report of all timber inspected, giving temperatures, amount of preservative, time of treatment, lengths and sizes of timbers, total footage, and other pertinent information. Treated timber which does not bear, in legible form, the stamp of the inspector shall not be shipped from the treating plant.

Each shipment of untreated lumber shall be inspected at its source by an inspector designated by the engineer, insofar as is economically practical. In cases where the engineer deems inspection at the source to be impractical, the material may be accepted on the basis of a "Certificate of Inspection" from a grading or inspection bureau or agency recognized as being competent.

The acceptance of any material or finished members by the inspector shall not be a bar to their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the contractor.

51.04 TREATED TIMBER. Treated timber shall be interpreted to mean timber treated by a pressure method to retain at least the minimum quantity per cubic foot of the preservative treatment stipulated in the table below. All treated timber, except piling, shall be treated with either creosote oil, creosote coal-tar solution, or a five percent solution of pentachlorophenol, unless otherwise specified. All treated timber piles shall be treated with either creosote oil or creosote coal-tar solution, unless otherwise specified.

**CREOSOTE, CREOSOTE COAL-TAR SOLUTION,
CREOSOTE PETROLEUM SOLUTION,
OR A 5% SOLUTION OF PENTACHLOROPHENOL**

MATERIAL	Minimum net retention of preservative per cubic foot of wood.
Structural Timber— 5 inches or less in thickness	10 lbs. empty cell
Structural Timber— more than 5 inches in thickness	8 lbs. empty cell
Fence Posts	6 lbs. empty cell
Guard Rail and Guide Posts	8 lbs. empty cell
Timber Piles	10 lbs. empty cell

SALTS TREATMENT	Pounds Dry Salt per Cubic Foot
Ammonical copper arsenite (Chemonite)	0.50
Chromated Zinc Chloride	1.15
Wolman salts (Tanalith)	0.55

Treatment of guide posts and guard rail posts shall be accomplished in such a manner and with such preservatives that will result in a surface to which paint will readily adhere without discoloration. The minimum depth of penetration shall be one-half ($\frac{1}{2}$) inch.

51.05 TIMBER PRESERVATIVES. These specifications cover the type and quality of materials used in the preservative treatment of timber. Materials include the following:

- Creosote oil
- Creosote coal-tar solution
- Creosote petroleum solution
- 5% solution of pentachlorophenol
- Ammonical copper arsenite (Chemonite)
- Chromated zinc chloride
- Wolman salts (Tanalith)

(a) All preservatives shall conform to AASHO M 133.

(b) **Method of Sampling and Testing.** Methods of sampling and testing shall conform to AASHO M 133.

(c) The use of all water-borne preservatives shall be subject to the limitations given in Paragraph 6.1.3 of the Interim Federal Specifications TT-W-00571 (d).

51.06 METHOD OF MEASUREMENT. Unless otherwise provided, treated timber and untreated timber, complete in place according to the plans and specifications, will be measured separately by the thousand feet board measure. Measurements will be computed from the dimensions shown on the plans, unless changes in such dimensions have been authorized by the engineer. Standard timber sizes and lengths will be used in computations. This measurement will include only such timber as is a part of the completed and accepted work, and will not include timber used for erection purposes, such as falsework, forms, bracing, sheeting, etc.

51.07 BASIS OF PAYMENT. The quantities, determined as provided above, shall be paid for at the contract unit prices per thousand feet board measure, (M.b.m.) for "Untreated Timber" or "Treated Timber" as the case may be, which prices

and payments shall constitute full compensation for procuring, furnishing, and delivering all lumber and timber, for any preservative treatment required, for all hardware, and all other metal parts used in the item, for preparing, framing, assembling, erecting, and painting, and for all labor, equipment, tools and incidentals necessary to complete the item.

Timber bumpers at the end of concrete floor slabs shall be considered an incidental part of The Work paid for under Section 46.

SECTION 52

PILING

52.01 DESCRIPTION. "Piling" shall consist of furnishing and placing piling in conformity with the plans and the specifications or as ordered in writing by the engineer. Foundation, trestle and sheet piles shall be untreated timber, treated timber, concrete or structural steel, all as shown on the plans and called for in the proposal. No alternate types or kinds of piling, save such as are shown on the plans or as called for in the specifications, shall be used.

52.02 REQUIREMENTS FOR ALL PILING. Piling shall be designed to sustain the total pressure which may be transmitted to the foundation. Piles shall be spaced not closer than 2 feet 6 inches center to center unless they rest on a hard stratum and act as columns. The distance from the side of any pile to the nearest edge of the footing shall not be less than 9 inches. In general, piles shall be used only in places where a minimum penetration of 10 feet in firm material, or 20 feet in soft material, can be obtained. For foundations of arch, continuous span, or movable bridges, or high abutments the piles shall be completely embedded in firm earth, sand, or gravel which will afford good lateral support. When this result is impracticable, the soft material shall be excavated from the pit and replaced by heavy riprap, for such distance and depth as the plans indicate or the engineer directs.

In general, all excavations of the foundation in which piles are to be driven shall be complete before driving is commenced. After driving is completed all loose and displaced materials shall be removed from around piles, leaving a clean, solid surface to receive the concrete.

When subject to transverse forces, batter piles shall be driven in sufficient numbers to resist the transverse forces without assistance from the vertical piles.

Unless otherwise specified on the plans or in the special provisions, the contractor shall be responsible for determining the length of all piles except timber trestle piles. Piles for

timber trestles shall be of the lengths shown on the plans and called for in the proposal, unless otherwise ordered in writing.

The Work shall be subject, at all times, to inspection by the engineer. The acceptance of any material or finished members by the inspector shall not be a bar to their subsequent rejection, if found defective. Rejected materials and workmanship shall be replaced promptly or made good by the contractor.

52.03 TIMBER PILING. **(A) Description.** Timber piles shall consist of round or square timber of the kind and dimensions specified, driven in the location and to the elevation shown on the plans or as directed by the engineer, and in conformity with these specifications.

(B) General. Timber which will be below water level at all times may be of any species of wood which will satisfactorily withstand driving.

In untreated piling for use in exposed work, the diameter of the heartwood at the butt shall be not less than 0.8 of the required diameter of the pile. For treated piles, Douglas Fir, Southern Yellow Pine, or Western Larch timber shall be used. Treating may be done with either creosote or creosote coal-tar solution. Piles shall be treated according to current AWPA Standard Specifications for Preservative Treatment by Pressure Process, for a net retention of preservatives of not less than that set forth under Section 51.

The penetration of preservative, as determined by borings made at any point on the pile, shall be full depth of the sapwood and not less than $\frac{1}{2}$ inch for all piles except Douglas Fir. Douglas Fir piles shall be so treated to obtain a minimum of $\frac{3}{4}$ inch penetration of preservative. All holes made for determining penetration shall be filled with tight fitting treated plugs.

(C) Quality. All piling shall be cut from sound trees, and shall be free from any defects which might impair their strength or durability. At least 9 inches of heartwood shall show on the butt. Piling shall contain no unsound knots. Sound knots will be permitted provided the diameter of the knot does not exceed 4 inches or one-third of the diameter of the stick at the point where it occurs. Any defects or combination of defects which will impair the strength or durability of the pile more than the maximum allowable knot shall not be permitted. Piles shall be cut above the ground swell and shall have a uniform taper from butt to tip. A line drawn from the center of the tip to the center of the butt shall not lie further from the center of the pile at any point than 1 percent of the length of the pile, but not to exceed 3 inches. Piles with short or reverse bends or kinks shall not be accepted. Piles with spiral grain which makes one complete turn in 50 feet or less shall not be accepted.

Unless otherwise specified, all piles shall be peeled by removing all of the rough bark and at least 80 percent of the inner bark. No strip of bark remaining on the stick shall be

over $\frac{3}{4}$ inch wide and there shall be at least 1 inch of clean wood surface between any two such strips. No less than 80 percent of the surface on any circumference shall be clean wood. All knots shall be trimmed close to the body of the pile. The butts shall be sawed square and the tips shall be sawed square or tapered to a point not less than 4 inches in diameter, as directed by the engineer.

(D) Inspection. Untreated timber piles shall be inspected at the site of the work by the engineer.

Treated timber piles shall be inspected at the creosoting plant before treatment for grade and suitability by an inspector designated by the engineer. The inspector shall stamp each pile on the butt end with a stamp which will make an impression that is readily legible after treatment. The stamp shall be copyrighted by the inspector and a true impression filed with The Commission. After treatment the piles shall again be inspected by the inspector, who shall stamp each pile on the butt end with a stamp differing from that used before treatment, and of which a true impression has also been filed with The Commission. The inspector shall file with The Commission an itemized report of all piles inspected, giving temperatures, amount of preservative, time of treatment, lengths and sizes, total footage, and any other pertinent information. Treated timber piles which do not bear, in legible form, the stamps of the inspector made both before and after treatment shall not be shipped from the creosoting plant.

(E) Dimensions. Round piles shall have a minimum diameter at the tip, measured under the bark, as follows:

Length of Pile	Tip Diameter
Less than 40 feet	8 inches
40 to 60 feet	7 inches
Over 60 feet	6 inches

The minimum diameter of piles at a section 3 feet from the butt, measured under the bark, shall be as follows:

Length of Pile	Southern Yellow Pine Western Larch Douglas Fir	All Other Species
20 feet and under	11 inches	11 inches
21 to 30 feet	12 inches	12 inches
31 to 40 feet	12 inches	13 inches
Over 40 feet	13 inches	14 inches

The diameter of the piles at the butt shall not exceed 20 inches. Square piles shall have the dimensions shown on the plans.

(F) Methods of Construction. The tops of all piles shall be sawed to a true plane as shown on the plans, and at the elevation fixed by the engineer. Piles which support timber caps or grillage shall be sawed to conform to the plane of the bottom of the super-imposed structure. In general, the length of pile above the elevation of cut-off shall be sufficient to permit the complete removal of all material injured by driving, but piling driven to very nearly the cut-off elevation shall be carefully freed of all splintered or otherwise injured material.

In timber trestle construction ,the piles for any one bent shall be carefully selected as to size to avoid undue bending or distortion of sway bracing. However, care shall be exercised in the distribution of piles of varying sizes to secure uniform strength and rigidity in the bents for any given structure.

Collars or bands to protect timber piles against splitting and brooming shall be provided where necessary.

Timber piles shall be pointed where soil conditions require it. When necessary, the piles shall be shod with metal shoes as shown on the plans or of a design satisfactory to the engineer, the points of the piles being carefully shaped to secure an even and uniform bearing on the shoes.

52.04 CONCRETE PILING. **(A) Description.** Concrete piles shall be made in accordance with the specifications and the designs shown on the plans. They shall be placed in accordance with the specifications in the location and to the elevation shown on the plans or as directed.

(B) Material. All concrete materials and their preparation and placing shall be in accordance with the requirements for Class "AD" concrete, as set forth in Section 46, and an air-entraining agent shall be added.

Reinforcement shall conform to Section 47 and the size and length shall be shown on the plans.

Where waterproofing is to be used, special provisions will be given and The Work shall be in accordance therewith.

(C) Method of Construction. Precast piles shall be made in accordance with the plans, and reinforcement shall be accurately placed and rigidly secured in such manner as to insure its proper location in the completed pile. Special reinforcement at the top and bottom to protect them from damage in driving shall be provided. The centers of the main reinforcing bars shall be not closer to the surface of the concrete than $2\frac{1}{2}$ inches. The concrete shall be carefully placed, tamped, and spaded, care being taken to fill every part of the form and to work the concrete around and under the reinforcement without displacing it. The piles shall be cast separately, or, if alternate piles are cast in a tier, the intermediate piles shall not be poured until 4 days after pouring the adjacent piles. Piles cast in tiers shall be separated by tar paper carefully placed. The concrete shall be placed continuously in each pile.

The completed piles must be free from stone pockets, porous spots, or other defects, and be straight and true to the form specified. The forms shall be true to line, built of surfaced lumber and a 1 inch chamfer strip shall be used in all right-angle corners; they shall be water-tight and shall not be removed within 24 hours after the concrete is placed. The piles shall be cured at least 40 days at a temperature of not less than 40°F., or 28 days at a temperature of not less than 60°F. Piles shall not be driven until this curing time is completed. When concrete piles are lifted or moved they shall be supported at the quarter points and they shall be so designed that the unit stresses produced by handling, as described above, will not exceed 650 pounds per square inch compression in concrete nor 12,000 pounds per square inch tension in steel.

(D) Piles Cast in Place. Piles shall be constructed in accordance with details shown on the plans.

At all times prior to the placing of concrete in the driven shells, the contractor shall have available a suitable light for the inspection of each shell throughout its length. Any improperly driven, broken or otherwise defective shell shall be corrected to the satisfaction of the engineer, by removal and replacement, or the driving of an additional pile, at no extra cost to The Commission.

Accumulations of water in the shell shall be removed before the concrete is placed. No concrete shall be placed until all driving within a radius of 15 feet has been completed, nor until all the shells for any one bent have been completely driven. If this cannot be done, all driving within the above limits shall be discontinued until the concrete in the last pile cast has set at least 7 days.

52.05 STRUCTURAL STEEL PILES. Structural steel piles shall be rolled steel sections of the weight and shape called for on the plans. They shall be structural steel conforming to ASTM A 7. Piles bent or otherwise injured will be rejected.

52.06 DRIVING. (A) Untreated Timber. Timber piles shall be driven with a gravity hammer, steam hammer or a combination of water jets and hammer.

Gravity hammers for driving timber piles shall weigh not less than 3,000 pounds and in no case shall the weight of the hammer be less than the combined weight of driving head and pile. The fall shall be so regulated as to avoid injury to the piles and in no case shall exceed 15 feet. When a steam hammer is used, the total energy developed by the hammer shall be not less than 6,000 foot pounds per blow.

Pile driver leads shall be constructed in such a manner as to afford freedom of movement to the hammer and they shall be held in position by guys or stiff braces to insure support to the pile during driving. Except where piles are driven through

water, the leads preferably shall be of sufficient length so that the use of a follower will not be necessary.

Water jets may be used in combination with a hammer. The volume and pressure of the water at the jet nozzle, and the number of jets used, shall be sufficient to freely erode the material adjacent to the pile. If water jets and a hammer are used for driving, the jets shall be withdrawn and the pile shall be driven by the hammer to secure the final penetration. This procedure may be varied if the desired results are not obtained.

Piles shall be driven strictly in accordance with the lines and spacing shown on the plans, and not more than $\frac{1}{4}$ inch variation per foot from the vertical or from the batter line will be allowed. Unless otherwise ordered in writing, timber piling shall be driven to a minimum bearing value of 20 tons, but in no case less than the design loads shown on the plans. In the absence of loading tests, the safe bearing values shall be determined by the following formulae:

$$\text{For single acting steam hammers} \quad P = \frac{2 W H}{S + 0.1}$$

$$\text{For double acting steam hammers} \quad P = \frac{2H (W + Ap)}{S + 0.1}$$

$$\text{For gravity hammers} \quad P = \frac{2 W H}{S + 1.0}$$

Where **P** — safe load per pile in pounds,

W — weight in pounds of striking part of hammer,

H — height of fall in feet,

A — area of piston in square inches,

p — steam pressure in pounds per square inch at hammer,

S — the average penetration in inches per blow for the last 10 to 20 blows for steam hammers, or of 5 to 10 blows for gravity hammers.

These formulae are applicable only when

- (a) The hammer has a free fall.
- (b) The penetration is at a reasonably quick and uniform rate.
- (c) There is no sensible bounce after the blow. Twice the height of the bounce shall be deducted from "H" to determine its true value in the formula.
- (d) The head of the pile is not broomed or crushed.
- (e) A follower is not used.

(B) Treated Timber. Driving of treated timber piling shall be identical with that prescribed for untreated timber piling, with the following additional requirements applying to treated timber piling:

Treated piles and timbers shall be carefully handled without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. They shall be handled with rope slings. Cant dogs, hooks, or pike poles shall not be used.

All places where the surface of treated piles or timbers is broken by cutting, boring, or otherwise, shall be thoroughly coated with hot creosote oil and then with a coating of hot tar. Hot creosote oil shall be poured into the bolt holes before the insertion of the bolts in such manner that the entire surface of the holes shall receive a coating of the oil.

(C) Concrete Piles. Unless otherwise provided, concrete piles shall be driven with a steam hammer which shall develop an energy per blow at each full stroke of the piston of not less than one foot-pound for each pound of weight driven. In no case shall the total energy developed by the hammer be less than 6,000 foot pounds per blow. If a gravity hammer is used, it shall have a weight not less than 50 per cent of the weight of the pile, but in no case less than 3,000 pounds, and the drop of the hammer shall not exceed 8 feet.

In driving, the tops of the piles shall be protected by suitable cushions of wood, rope or other material, so placed as to reduce the injury to the pile to a minimum. Metal shoes or points of an approved design shall be used when so ordered. Concrete piles shall be driven in accordance with the requirements of Part (A) of this Article to sustain safely the design loads shown on the plans.

(D) Structural Steel Piles. Steel piles shall be driven in accordance with Part (A) of this Article to sustain safely the design loads shown on the plans. The heads shall be cut squarely and an approved cast or structural steel driving cap shall be provided to hold the axis of the pile in line with the axis of the hammer and to prevent deformation of flange or web.

(E) Treatment of Pile Heads After Cut-off. After the necessary cutting has been done to receive the cap, the heads of all timber piles shall be given 3 coats of hot creosote oil. Unless embedded in concrete, they shall then be covered with a coat of hot tar, over which will be placed a sheet of Gage 22 galvanized iron, or a sheet of pure zinc, aluminum, copper, or any other approved non-rusting material of equal thickness, or a covering may be built-up of alternate layers of hot tar and loose woven fabric, conforming to AASHO M 117, using 4 layers of tar and 3 of fabric. The cover shall measure at least 6 inches more in each dimension than the diameter of the pile and shall be bent down over the pile and the edges fastened with large-headed nails. After the cover material is in place, the cap shall be placed and drift-pinned as specified in Section 43.

(F) Modification of Spacing. In case the above carrying capacity cannot be obtained, plans showing the necessary modification of the design of the footings and the number and location of the piles required shall be furnished by the engineer.

52.07 SPLICING OF PILES. Full length piles shall always be used where practicable but if splices cannot be avoided splicing shall be done according to methods shown on the plans or as directed. When the splicing of steel piles or steel shells of special piles is done by welding the arc method shall be given preference.

Extensions, splices or build-ups on concrete piles, when necessary, shall be made as follows: After the driving is completed, the concrete at the end of the pile shall be cut away, leaving the reinforcing steel exposed for a length of 40 diameters. The final cut of the concrete shall be perpendicular to the axis of the pile. Reinforcement similar to that used in the pile shall be securely fastened to the projecting steel and the necessary form work shall be placed, care being taken to prevent leakage along the pile. Just prior to placing concrete, the top of the pile shall be thoroughly wetted and covered with a thin coating of neat cement, retempered mortar or other suitable bonding material. The forms shall remain in place not less than 7 days and then shall be carefully removed and the entire exposed surface of the pile finished as above specified.

52.08 LOADING TESTS. If specified on the plans or in the special provisions, or if for any reason the engineer deems it advisable to make load tests on one or more piles, the contractor shall load the test piles with a test load equivalent to twice the bearing value to which the piling is to be driven as shown on the plans or specified. The loading platform shall be so constructed that the readings may be taken directly on the pile. Care shall be exercised in cutting off and capping the piling to insure an even bearing surface in a horizontal plane over the entire end of the piling. The loading platform shall be so constructed and the loading material shall be of such a character as to permit the load being evenly balanced and distributed over the bearing area of the piling.

In lieu of a loading platform, hydraulic jacks with suitable yokes and pressure gages may be used.

The pile shall first be loaded with 25 per cent of the test load, this load being allowed to remain undisturbed for a period of 6 hours. The loading shall then be increased to 50 per cent of the test load, after which a period of test of 12 hours shall be allowed before further loading. The remainder of the test load shall be applied half at a time with a period of 6 hours between loadings. The entire test shall be allowed to remain in place for a period of 48 hours, after which the test load shall be removed and the platform dismantled.

The permanent settlement shall not exceed $\frac{1}{4}$ inch in 48 hours unless otherwise specified. If the permanent settlement exceeds $\frac{1}{4}$ inch in 48 hours, the engineer may order the load reduced until the maximum load is determined which will not cause a settlement in excess of the allowable. In case the safe carrying capacity of any pile is found by test, or by formula if not tested, to be less than the load that it was intended to

carry, additional piles shall be driven until the load per pile to be borne is reduced to safe carrying capacity.

52.09 TEST PILES. For his information the contractor may drive such test piles as he may believe necessary, provided, however, that the number of test piles to be paid for as such shall not exceed the number of test piles authorized on the plans or ordered in writing.

In all cases he shall furnish the piles and necessary equipment. The location and manner of driving of test piles shall be at the discretion of the contractor, save that the contractor shall cooperate with the engineer in facilitating the keeping of accurate records of driving and complete field data, and, after he has finished with any individual test pile, shall drive such test pile to any deeper penetration that the engineer may order, and save that when so indicated on the plans, the location and manner of driving of test piles shall be as ordered. Unless otherwise indicated on the plans, the test piles furnished shall be of sufficient length to permit driving to practical refusal and shall be of the same section and size required for piles in the structure.

52.10 METHOD OF MEASUREMENT. Untreated timber piles, treated timber piles, and concrete piles shall be paid for on the basis of the lineal feet of piling left in place in the completed and accepted structure, or at a unit price per pile, unless otherwise called for on the plans or in the special provisions.

Quantities used in payment for structural steel piles shall include the materials and work specified under "Steel Bearing Piles" and "Driving Steel Bearing Piles" as follows:

(A) Steel Bearing Piles. The quantity to be paid for shall be the number of pounds of structural steel in the steel bearing piles, and in the materials used in splicing where same is specified, computed from the nominal weights of the specified sections. To this computed weight shall be added the weights of all welds incidental to the splicing where same is specified.

(B) Driving Steel Bearing Piles. The quantity to be paid for under this item shall be computed on the basis of the lineal feet of piling driven below the bottoms of the substructure units.

Test piles, whether or not utilized as service piles in the structure, shall not be included in the above. The number of test piles to be paid for shall be the number of test piles driven as ordered, provided however, that the number shall not exceed the number of test piles authorized on the plans or ordered in writing.

The number of loading tests to be paid for shall be the number of loading tests made, completed and accepted.

The number of pile shoes to be paid for shall be the number of shoes of approved design ordered and used on accepted piles.

When any item specified under this section is bid on a lump sum basis there will be no measurement of weight, length or unit.

52.11 BASIS OF PAYMENT. Untreated timber piling, treated timber piling, and concrete piling shall be paid for at the unit price bid per pile, or at the unit price bid per lineal foot determined as provided above, as called for in the proposal, complete in place, which prices and payment shall constitute full compensation for The Work, unless otherwise provided for on the plans or in the special provisions.

Steel bearing piles shall be paid for at the unit price bid per pound for the quantity as determined above; which price and payment shall constitute full compensation for all materials delivered at the site and shall include all costs necessary and incidental to the cutting off of piles if required, and to the capping of same, where specified on the design plans.

Driving steel bearing piles shall be paid for at the unit price bid per lineal foot for the footage as determined above, which prices and payment shall constitute full compensation for The Work.

Test piles, determined as provided above, shall be paid for at the price bid, which price and payment shall constitute full compensation for The Work.

The number of loading test of piles, determined as provided above, shall be paid for at the contract unit price each for "Loading Test of Piles," which price and payment shall constitute full compensation for building the loading platform, procuring and placing the loading material, and removing and disposing of the platform and material, or for furnishing necessary equipment for other approved methods of testing, for making the test and for removing the equipment.

The number of piles shoes, determined as provided above, shall be paid for at the contract unit price for each "Pile Shoes," which price and payment shall constitute full compensation both for furnishing the shoes and for utilizing the same on piles as ordered.

When any item specified under this section is bid on a lump sum basis, payment shall be made accordingly and the same general provisions cited above shall apply.

SECTION 53

RAILING AND

MISCELLANEOUS STRUCTURE ITEMS

53.01 DESCRIPTION. This section shall pertain to the furnishing and installation of steel beam bridge rail, other types of railing, curbs, guard fences, water proofing and other miscellaneous items enumerated in Section 100 or as may be added thereto. Materials and procedures shall conform to the provisions of this or other pertinent sections of the specifications, to the plans or standard drawings or as may be especially provided or directed.

53.02 MATERIAL. (A) **Steel Beam Bridge Rail.** This item shall consist of rail units fabricated to develop continuous beam strength and installed in accordance with Drawing No. SBBR. The rail shall be Gage 12 except as noted on the plans.

The beam rail and terminal sections shall conform to AASHO M 180 but shall not be galvanized; they shall be shop painted as specified by M 180. Bolts and nuts shall be galvanized.

All metal parts shall be thoroughly cleaned and then painted in accordance with Article 54.06(E) (1).

(B) **Other Items.** Other items listed under this section shall be of the type of material prescribed in the special provisions, the plans, standard drawings or specified otherwise within the contract. Corrugated asbestos-cement sheets shall conform to ASTM C 221. Asphalt plank shall conform to ASTM D 517. Coal-tar waterproofing shall conform to ASTM D 450.

53.03 CONSTRUCTION METHODS. (A) Steel beam bridge rail shall be installed in accordance with provisions in the plans, as may be set forth in special provisions or as directed by the engineer.

(B) **Other Items.** Other items covered by this section shall be installed or constructed in accordance with pertinent plans, specifications, standard drawings, special provisions or as directed.

53.04 METHODS OF MEASUREMENT. (A) Steel beam bridge rail shall be measured by the lineal foot, complete in place and accepted.

(B) **Other Items.** Other items covered by this section shall be measured as indicated by the list of items shown in Section 100 or in the proposal.

53.05 BASIS OF PAYMENT. (A) Steel beam bridge rail shall be paid for at the unit price bid for the item which shall be full compensation for The Work.

(B) **Other Items.** Other items covered by this section shall be paid for at the unit price bid for each item which shall be full compensation for The Work.

SECTION 54

PAINTS AND PAINTING

54.01 GENERAL REQUIREMENTS. Paint shall consist of pigments of the specified composition ground to the required fineness in the specified vehicles, to which shall be added thinner and drier, as may be required in the Specifications for each kind of paint. The paint shall not cake, liver, thicken, curdle, gel, or settle badly, shall be readily broken up with a paddle to a smooth uniformity of good brushing consistency, and shall dry to a uniform texture without streaking, running or sagging when applied to a vertical surface.

When applied in a normal brushing coat under normal conditions of temperature and humidity, paint shall dry hard and tough in not more than twenty-four (24) hours, unless otherwise specified in Article 54.04.

The painting of metal structures, posts, poles, supports, etc., shall include, unless otherwise provided in the contract, the proper preparation of the metal surfaces, the application, protection and drying of the paint coatings, the protection of pedestrians, vehicular or other traffic upon or underneath the bridge structure or other structures, the protection of all portions of the structure (superstructure and substructure) against disfigurement by spatters, splashes and smirches of paint or of paint materials, and the supplying of all tools, tackle, scaffolding, labor, workmanship and materials necessary for the entire work.

54.02 PACKING AND MARKING. Paint shall be delivered in such containers as may be ordered or specified. Each container shall bear a label with the following information shown thereon: Name and address of the manufacturer, shipping point, trademark or trade name, kind of paint, formula, number of gallons, date and lot number. Each paint container shall be labeled in accordance with statutes enacted by the 1959 Legislative Assembly.

54.03 SAMPLING AND TESTING. No paints shall be used previous to the receipt of an acceptance and report from the laboratory.

Representative samples of paints or paint ingredients shall be taken at the point of delivery and submitted to the laboratory by the inspector.

Acceptance of paints or paint ingredients on the basis of a certified formula or analysis submitted by the manufacturer may be made at the discretion of the laboratory.

54.04 MATERIALS. (A) Pigments, Vehicles and Thinners. All materials from which paints are made and formulated shall

comply with the specifications set forth below opposite successive item numbers:

(1) Basic Carbonate White Lead Pigment	AASHO M 122
(2) Basic Sulfate White Lead Pigment	AASHO M 123
(3) Zinc Oxide Pigments	AASHO M 124
(4) Mineral Iron Oxide Pigments	AASHO M 129
(5) Pure Chrome Green Pigment	AASHO M 130
(6) Iron Blue Pigment	AASHO M 131
(7) Leaded Zinc Oxide Pigment	ASTM D 80
(8) Zinc Sulfide Pigments	ASTM D 477
(9) Calcium Carbonate Pigments	ASTM D 1199
(10) Titanium Dioxide Pigments	ASTM D 476
(11) Bone Black Pigment	ASTM D 210
(12) Carbon Black Pigment	ASTM D 561
(13) Black Synthetic Iron Oxide Pigment	ASTM D 769
(14) Red and Brown Iron Oxide Pigments	ASTM D 84
(15) Ochre (Ferrous earthy pigments)	ASTM D 85
(16) Raw and Burnt Umber (Pigments)	ASTM D 763
(17) Raw and Burnt Sienna (Pigments)	ASTM D 765
(18) Venetian Red Pigment	ASTM D 767
(19) Copper Phthalocyanine Blue Pigment	ASTM D 963
(20) Iron Blue Pigment	ASTM D 261
(21) Ultramarine Blue Pigments	ASTM D 262
(22) Blue Lead Pigment (Basic Sulfate)	ASTM D 405
(23) Reduced Chrome Green Pigment (grinders green)	ASTM D 213
(24) Chrome Oxide Green Pigment	ASTM D 263
(25) Chrome Yellow and Chrome Orange Pigments	ASTM D 211
(26) Zinc Yellow (Zinc Chromate) Pigment	ASTM D 478
(27) Yellow Iron Oxide Pigment—hydrated	ASTM D 768
(28) Red Lead Pigment	ASTM D 83
(29) Aluminum Pigments	ASTM D 962
(30) Zinc Dust (pigment)	ASTM D 520
(31) Magnesium Silicate Pigments	ASTM D 605
(32) Diatomaceous Silica Pigments	ASTM D 604
(33) Mica Pigment	ASTM D 607
(34) Raw Linseed Oil	AASHO M 125
(35) Boiled Linseed Oil	AASHO M 126
(36) Spirits of Turpentine	AASHO M 127
(37) Petroleum Spirits (Mineral Spirits)	AASHO M 128
(38) Lampblack	ASTM D 209
(39) Liquid Paint Driers	ASTM D 600
(40) Raw Tung Oil	ASTM D 12

(B) Paints and Enamels. Paints and enamels shall be formulated and made as provided in the specifications listed below by formula numbers:

(1) Foliage Green Bridge Paint	AASHO M 67
(2) Black Bridge Paint	ASSHO M 68

When two coats of this paint are required, sufficient red

lead shall be used to tint the first coat so as to provide a contrast with the second coat.

- (3) Aluminum Paint AASHO M 69
The use of ready-mixed aluminum paint will not be permitted. Aluminum paint shall be made up of two pounds of aluminum paste mixed with one gallon of varnish.
- (4) White and Tinted Ready-Mixed Paint ASSHO M 70
Second coat white (body) and third coat white (finish) shall be Type 1, Class 'A'; as an alternative, Federal Specification TT-P-102, Class A, will be accepted. This also applies to other colors.
- (5) Red Lead (Dry and Paste-in-oil) and paint made therefrom AASHO M 71
- (6) Red Lead Ready-Mixed Paint AASHO M 72
Use Type I for Shop Coat and Type IV for first field coat.
- (7) Zinc Chromate-Iron Oxide Ready-Mixed Paint AASHO M 142
- (8) First coat white (Prime) for use on wood, shall be made up of 100 pounds White Lead Paste (9% linseed oil) which may be either Item 1 or Item 2, Part (A), or a mixture thereof.
5 gallons raw linseed oil — Item 11, Part (A)
2 gallons turpentine — Item 13, Part (A)
1 pint drier — Item 19, Part (A)
- (9) Black paint to be used on wood shall be made up of
20 pounds lampblack — Item 18, Part (A)
4½ gallons raw linseed oil — Item 11, Part (A)
2 quarts turpentine — Item 13, Part (A)
1 pint drier — Item 19, Part (A)
- (10) When Item 7 is used as prime coat and also as first coat, about 0.3% of lampblack, Item 38, Part (A), shall be added to produce color differential.
- (11) Items 1, 2, 3, 5, 6, and 7, Part (A) to be used on metal bases, unless specified otherwise. Items (6) and (7) are acceptable as prime or shop coat. Items 4, 8, and 9, Part (B) to be used on wood bases, unless specified otherwise.
- (12) **Equipment Enamel.** Shall be formulated in accordance with Federal Specification TT-E-489b, Class A; spray or brush consistency as specified; color No. 12197 of Federal Standard No. 595. Thinner, conforming to Federal Specification TT-T-306, shall be used, when necessary, at a rate not to exceed one pint per gallon.
- (13) **Traffic Line Paint.** Traffic line paint, such as generally used on highway centerlines and at intersections, shall conform to the following requirements:
(a) **Materials.** The choice of class, type and brand of all ingredient materials is left to the discretion and ingenuity of

the manufacturer. Sample of ingredient materials may be required for reference purposes. Rubber-base paint will be considered and will be subject to the approval of the laboratory. All materials shall conform to the latest revised American Society for Testing Materials specifications wherever such specifications apply.

(b) Manufacture. The ingredient materials shall be mixed and ground to produce a homogenous paint, free of foreign material, which will not thicken, gel, liver, curdle or settle on long periods of storage, and shall be readily broken up to a uniform condition capable of application without clogging the spray gun nozzle or causing other operating difficulties. The paint must dry to an elastic adherent finish and show no appreciable discoloration with age. The volatile material shall have a minimum solvent action on asphalt. The non-volatile matter shall be of such quality that it will not darken or become yellow when a thin section is exposed to sunlight. The manufacturer's equipment and process shall be made available for inspection by an authorized inspector.

(c) Analysis. All prospective suppliers will be required to furnish a notarized analysis and manufacturer's guarantee in triplicate. Such analysis shall state the complete composition and shall show the percentages of each of the raw materials used in formulating the paint. The manufacturer's guarantee shall certify that the paint will comply with these specifications. The manufacturer's formulation will be treated as confidential, and will not be revealed without his consent.

(d) Pigment. The pigment for yellow traffic line paint shall be a combination of inorganic colors and white pigment to produce the proper color. Yellow paint shall contain a minimum of 1½ pounds of C.P. medium chrome yellow per gallon. The pigment for white traffic line paint shall be a combination of white pigments which will produce the proper color.

(e) Vehicle. The vehicle shall be an alkyd resin solution meeting the following specifications:

Non-Volatile	-----	59 - 61%
Volatile	-----	Mineral spirits or VM & P naphtha
Viscosity (Gardner Holdt)	-----	z - z-4
Acid No. of Solution	-----	10 Max.
Color (Gardner 1933 Std's.)	-----	9 Max.
Sp. Grav. of solution	-----	.920 - .950

The non-volatile vehicle shall be an alkyd resin consisting only of:

Polyhydroxyl Alcohol	-----	15 - 21%
Phthalic Anhydride	-----	30 - 40%
Drying Oil Acids	-----	45 - 60%

The resin shall not exceed 1% unsaponifiable matter by weight. The resin shall show a negative resin test and a negative phenolic compound test. The drying oils shall be limited to linseed and/or soybean oil.

(f) **Color.** A standard color chip will be furnished each bidder for the yellow and white traffic line paint, if and when the engineer so desires.

(g) **Viscosity.** The viscosity shall be seventy (plus or minus five) Krebs Units not less than four days after manufacture at 25° C. and shall not be more than ninety Krebs Units at 5° C.

(h) **Drying Time.** When tested by the prescribed method, the paint shall dry to no pickup in not less than 10 minutes and not more than 30 minutes and shall dry hard within one hour.

(i) **Bleeding.** There shall be no bleeding or discoloration of the paint film when subjected to the prescribed test.

(j) **Water Test.** There shall be no blistering, peeling, or wrinkling of the paint film when subjected to the prescribed test.

(k) **Flexibility.** The film shall not crack when subjected to the prescribed flexibility test.

(l) **Adhesion.** There shall be no cracking, chipping, or peeling when subjected to the prescribed adhesion test.

(m) **Fineness.** The fineness of grind shall not be less than 3 when tested by the North Standard Fineness Gage.

(n) **Skinning.** There shall be no skinning in a half filled pint container in less than 24 hours.

(o) **Settling.** The pigment shall not settle or cake in the container on long periods of storage. An accelerated method of settling evaluation is listed under test.

(p) **Abrasion.** When subjected to the specified Taber Abrasion test, the loss in weight of paint film shall not be more than one-tenth (0.1) gram per one thousand revolutions.

(q) **Hiding.** The paint shall completely hide black when applied at the rate of one gallon per 175 square feet.

(r) **Film Appearance.** The paint shall dry to a flat finish.

(s) **Testing Procedure.** Testing of the paint shall be in accordance with the methods specified by the American Society for Testing Materials, Federal Test Method Standard No. 141, latest revision, or alternate tests and methods approved by the engineer.

(t) **Samples.** Prior to the opening date of bids, all prospective suppliers will be required to submit the following samples to the laboratory: One gallon sample, two one-quart samples. The successful bidder will be required to submit two

one-pint samples of his paint from each batch of paint together with certified affidavits that the paint manufactured complies with the formulation of these specifications and that the samples are representative of the batches manufactured.

(14) **Beaded Traffic Line Paint.** Glass beads or spheres shall be imbedded in traffic line paint when so specified. The paint vehicle in this product shall conform to the provisions of Part

(13) above with the exception that the viscosity shall be not less than 75 nor more than 95 Krebs Units at 25° C. and Part

(13)(m) Fineness, shall not apply.

Each gallon of beaded traffic line paint shall contain, or shall be accompanied by, not less than 4 pounds of glass beads. The beads shall be uniformly transparent and not less than 80% shall be true spheres; i.e., neither ovate nor fused twins. The engineer shall decide whether the beads will be applied in and with the paint or following the application of the paint to the surface.

The beads shall conform to an index of refraction range of 1.50 to 1.65.

The beads shall conform to the following grading requirements, using U.S. Standard screens:

Passing a No. 60 and retained on a No. 70	0.0%
Passing a No. 70 and retained on a No. 80	15.0% Maximum
Passing a No. 80 and retained on a No. 230	85-100 %
Passing a No. 230	0- 10 %

Samples shall be submitted as set forth above in Part (13)(t).

(15) **White, Yellow and Black Enamel for Metal.** These shall be water-resisting enamels made with synthetic gums. They shall be suitable for brush application to vertical metal surfaces, without running, streaking or sagging, and shall conform to characteristics set forth below:

	White	Yellow	Black
Coarse particles and skins retained on No. 325 sieve, not over	0.50%	0.50%	0.50%
Non-volatile matter, not less than	85%	85%	85%
Set to touch at room temperature, Not over, hours	5	5	5
Dry hard at room temperature, Not over, hours	24	24	24
Toughness, Kauri reduction test at 75° F., not less than	150%	150%	120%
Hiding power, square feet per gallon by Pfund cryptometer, Model E, black plates, not less than	300	450	
The dried films must withstand cold water for 18 hours and			

boiling water for 15 minutes without whitening, dulling or change in color. The enamels shall have good brushing, flowing, covering and leveling properties and must not cake in the container. The properties set forth above shall be determined in accordance with Federal Test Method Standard No. 141.

The white enamel shall be equal in brightness to that obtainable with rutile titanium-calcium pigment (ASTM D 476). Yellow enamel shall match a standard color sample for D-2 yellow guard rail paint. Black enamel shall be jet black and hide completely in one coat.

(16) **Brilliant Green Sign Enamel.** This enamel shall be a ready-mixed exterior paint meeting the requirements of Federal Specification TT-P-71b, except that a blend of titanium dioxide and tinting pigments shall be used instead of chrome green oxide. The paint shall match the color of a standard green sign enamel. It shall, when reduced with an equal weight of linseed oil, have a hiding power of not less than 750 square feet per gallon when measured on the Pfund Cryptometer, Model E, white plate, viewed in a light of approximately 50 foot-candle intensity.

(17) **Pretreatment for Rusted and Galvanized Surfaces.** Such areas shall be treated with a freshly prepared solution of phosphoric acid and conforming to Federal Specification MIL-P-15328, Diluent (A).

(18) **Concrete Paint.** (A) **White.** Concrete white paint shall consist of any suitable mixture of white pigments ground into a varnish base vehicle free from benzol and chlorinated solvents.

(1) Composition shall conform to the following by weight:

Total non-volatile material including pigment	60% Min.
Non-volatile material in vehicle	35 to 45%
Water	1.0% Max.

(2) The clear vehicle extracted with a super centrifuge shall pass a 0% (zero percent) Kauri Reduction Test.

(3) **Drying Time.** A medium brush coat on glass shall dry to touch in not less than 15 minutes or more than 2 hours and shall dry hard in not more than 16 hours.

(4) Daylight reflectance shall be not less than 75% relative to magnesium oxide.

(5) Consistency shall be not less than 65 nor more than 85 K.U.

(6) Dry Opacity shall be not less than 0.88 with the film applied with a 0.0025 inch Bird Film Applicator.

(B) **Black.** Concrete black paint shall be a mixture of tar pitch and oils which are light tar distillates and shall meet the following requirements:

(1) Viscosity, Saybolt Furol at 77° F. shall not exceed 100 seconds.

- (2) Water content shall not exceed 1.0% by weight.
- (3) When distilled according to ASTM D 20 the amount of distillate up to 572° F. shall be from 25% to 40%.
- (4) The color shall be a dense lustrous black.
- (5) At 70° F. the paint shall dry to touch in 20 minutes and dry free from tackiness in 45 minutes.

54.05 PREPARATION OF SURFACE. Rusted and galvanized metal surfaces to be painted shall be treated by brushing with a solution, conforming to Article 54.04(B)(17). After drying 20 minutes the metal surface shall be rinsed with water. Painting shall be started within 24 hours.

All surfaces shall be thoroughly clean and dry before and when the paint is applied. The cleaning shall remove all rust, loose mill or welding scale, dirt, oil, or grease, and other foreign substances. The removal of rust, scale, and dirt shall be done by the use of metal brushes, scrapers, chisels, hammers, sand blasting, flame cleaning, or other effective means. Oil and grease shall be removed by the use of gasoline or petroleum naptha. Bristle brushes shall be used for removing loose dust.

54.06 APPLICATION OF PAINT. **(A) General.** No painting shall be done under what the engineer judges to be adverse weather conditions. Surfaces being painted shall be at approximately the same temperature as the atmospheric temperature, and then only when the air temperature is 40° or higher. Each coat of paint shall be allowed to dry at least forty-eight (48) hours before the succeeding coat is applied. Prime coats may be applied at the mill or shop. Each primer and succeeding field coat of paint over metal shall have a minimum dry film thickness of 1.5 and 1.0 mils, respectively.

(B) Painting Structural Steel Work. **(1) Application.** All new structural steel work shall, unless otherwise especially provided upon the plans or in the contract, be given three coats of paint; this also shall apply to other steel and metal structures, such as sign posts, structures for signs and the like, that will be placed outside and exposed to weather. The painting shall be done in a neat and workmanlike manner. Paint shall be applied in full coats, either with brushes or spray, so that every part of the surface is completely covered.

When paint is applied with brushes the paint shall be so manipulated under the brush as to procure a uniform, even

coat in close contact with the metal or with previously applied paint. In general, the primary movement of the brush shall describe a series of small circles to thoroughly fill all irregularities in the surface, after which the coating shall be brushed out and smoothed by a series of parallel strokes until the paint film has an even thickness. Brushes preferably shall be round or oval in shape, but if flat brushes are used they shall not exceed 4 inches in width.

If spraying equipment is employed, it shall be of a type that will insure a satisfactory application of the paint specified. When spraying is used, the pressure tank shall have an agitator to keep the paint thoroughly stirred.

The paint shall be thoroughly stirred previously by means of approved mechanical mixers before being removed from the containers, and the pigments shall be kept in suspension by stirring during the application. When the quantity of each coat of paint required is 5 gallons or less, the engineer may, at his discretion, approve hand mixing.

If it is necessary in cool weather to thin the paint in order that it may be spread more freely, such thinning shall be done only by heating in hot water or on steam radiators.

On all surfaces which are inaccessible for paint brushes, the paint shall be applied with spray or sheepskin daubers especially constructed for the purpose.

Paint shall not be applied upon damp surfaces or upon metal containing frost, nor shall it be applied when the air is misty or when, in the opinion of the engineer, conditions are unsatisfactory for the work.

Materials painted under cover in damp or cool weather shall remain under cover until dry or until weather conditions permit their exposure in the open. Painting shall not be done when the metal is hot enough to cause the paint to blister and produce a porous paint film.

The contractor shall be responsible for the satisfactory application of paint, and neither weather conditions nor the laboratory acceptance of materials used in the paint shall relieve him of the responsibility of obtaining a satisfactory paint job. If, in the opinion of the engineer, the painting is unsatisfactory, the paint shall be removed and the metal thoroughly cleaned and repainted. No additional allowance will be made because of any expense incurred by these requirements.

(2) Shop Paint. All metal surfaces, except surfaces to be in contact after erection, shall receive one coat of red lead paint or zinc chromate primer meeting the requirements of Items (6) and (7), Article 54.04(B), unless otherwise specified herein or in the contract. The shop coat shall be applied immediately after fabrication, shop inspection and shop cleaning have been completed and the work has been accepted. Metal surfaces to be in contact after erection shall not be painted. Material shall not be loaded for shipment until the paint is dry.

Erection marks for the field identification of members shall be painted on painted surfaces. Erection marks, fabricators' names, etc., shall not show through the final coat of paint due to build-up of film thickness. The paint used for stenciling must be a type that will not be harmful to either the shop coat or the first field coat.

With the exception of abutting chord and column splices and column and truss shoe bases, machine-finished surfaces shall be coated as soon as practicable after being accepted, and before removal from the shop, with a hot mixture of white lead and tallow. Surfaces of iron and steel castings machine-finished for the sole purpose of removing scales, scabs, fins, blisters or other surface deformation shall be given the shop coat of paint.

The composition used for coating machine-finished surfaces shall be mixed in the following proportions: 4 pounds tallow, 2 pounds white lead, and 1 quart linseed oil.

(3) Field Cleaning. When the erection work, including all riveting, straightening of all bent material, etc., is complete, all adhering, rust, scale, dirt, grease, unsatisfactory shop paint and other foreign matter shall be removed as specified herein under Article 54.05.

(4) Field Painting. The outside faces of end floorbeams, the bottom of expansion devices, and all parts of steel work inaccessible for painting after erection, are to be thoroughly cleaned of all foreign matter, spot coated and painted their two field coats before erection. This painting shall be done on the site of erection and prior to the placement of the material to allow the paint to become thoroughly dry before assembling. Material so painted shall be in a position to require a minimum of handling after being painted, the handling to be done in such a manner as not to damage or abrade the painted surface. In case these painted surfaces are damaged during erection, they shall be properly repainted.

After erection and as soon as the field cleaning is done to the satisfaction of the engineer, the spot coat shall be applied to the heads of all field rivets, bolts, pins and nuts, to all abrasions of the shop coat, and to all surfaces on which the shop coat has become damaged. In certain cases where a large portion of shop coat has become defective due to long periods of storage or due to the action of water, mud or other substance, the engineer may require a substantially complete reconditioning or replacement of the shop coat. All such painting shall be considered as spot coat work.

All small cracks and cavities which have not been sealed in a water-tight manner by the first field coat, shall be sealed with red lead paste before second field coat is applied.

To secure a maximum thickness of paint film over rivet heads and edges of plates, angles and other rolled shapes, these

parts shall be painted an extra coat in advance of the general application of each field coat.

All metal, after the field cleaning has been completed and the spot coat has dried thoroughly, shall be given two coats of field paint consisting of the first field coat as specified by Article 54.04(B)(6) or (7) and one coat of aluminum paint as specified by Article 54.04(B)(3) unless otherwise provided in the contract. In no case shall a succeeding coat be applied until the previous coat has dried throughout the full thickness of the paint film. This will require at least 48 hours drying time between successive coats during suitable weather. During unsuitable weather, the interval between successive coats shall be increased at the discretion of the engineer.

Field painting of structural steel shall not be started prior to May 1, nor shall it continue later than September 30, except on written permission of the engineer.

(C) Painting Untreated Timbers. The surfaces named below shall be thoroughly coated with two coats of hot creosote oil before the timbers are assembled. Ends, tops and all contact surfaces of posts, sills, caps, floorbeams and stringers; all ends, joints and contact surfaces of bracing and truss members. All surfaces of timber bumpers, the back face of bulkheads and all other untreated timber which is to be in contact with earth shall be similarly treated.

Unless otherwise specified, untreated timber handrail and posts shall be painted with three coats of paint conforming to Formulas 4 and 8, Article 54.04(B). All timber to be painted must be seasoned, and painting shall be done only when the timber is free from frost and the surface is perfectly dry and clean. No painting shall be done in damp or freezing weather. All paints shall be thoroughly dry before applying the succeeding coats. It shall be applied in good heavy coats, completely covering every part of the surface and shall be worked into the joints and open spaces; it shall be so thoroughly and evenly spread that no excess paint will collect at any point.

(D) Painting Traffic Lines. The surface to be painted shall be swept clean and free of dirt, rocks, gravel and any other foreign matter. The paint shall be applied by hand or mechanical means consistent with the scope of the job. The paint shall be applied at a minimum rate of 25 gallons per mile of four inch width of solid line or as may be provided by the special provisions. The width and layout of stripes, or the area to be painted, shall conform to plans or standard drawings. Means satisfactory to the engineer shall be adopted to keep traffic off the paint until it has properly set and will not pick up.

(E) Painting Guard Rail. **(1) Metal Rail, Guard and Bridge.** Metal rail units, which are to be painted, shall be given one shop coat of paint before shipping. Before erection in

the field the first field coat, conforming to Article 54.04(B)(6), (7), or equal, shall be applied. After erection all abrasions on rail, bolts and heads shall be spotted with the latter paint before final application of second field coat of aluminum paint conforming to Article 54.04(B)(3).

Preparation for painting shall conform to Article 54.05. Applicable provisions of this Article, 54.06, also shall apply as to application.

(2) Wood Rail and Posts. Treated guide posts, when used in conjunction with "Ditch Lining," shall be painted with one coat of black paint, conforming to Article 54.04(B)(9), to an elevation even with the top of the headers. The remainder of each post shall be painted with three coats of white paint conforming to Article 54.04(B)(8) and (B)(4). Untreated wood posts and rail, when painted, shall receive one coat conforming to Article 54.04(B)(8) and two coats conforming to Article 54.04(B)(4). Application shall conform to Article 54.06(C).

54.07 METHOD OF MEASUREMENT AND BASIS OF PAYMENT. Paint and painting will not be measured separately or paid for directly, but shall be considered incidental and necessary to the work for which it is specified and shall be included in the payment for those items, unless specified otherwise.

When painting or traffic lines is specified as a bid item, measurement will be by the lump sum for the entire project, by the square yard or by the mile, dependent upon circumstances. Payment shall be made in like manner and such payment shall be full and complete compensation for The Work.

SECTION 57

RIPRAP

57.01 DESCRIPTION. "Riprap" shall consist of a revetment of the type specified, composed of stone, fragmented rock or concrete or sacked concrete, placed as a protective covering, along the slopes of embankments, around culvert inlets or outlets, around foundations, bridge berms, dykes or at such other places as may be directed in conformity with the plans and specifications.

57.02 HAND LAID AND RANDOM RIPRAP. (A) Material.

(1) **General.** The stone, fragmented rock or concrete shall be hard, sound, durable, free of weak laminations and cleavages and of a quality that will not disintegrate on exposure to water or weathering. It shall not have a wear exceeding forty-five (45) percent at five-hundred (500) revolutions as determined by AASHO T 96 (Los Angeles Rattler Test).

(2) **Hand Laid Riprap.** Each stone or fragment shall be not less than three inches thick nor contain less than one-half cubic foot in volume or weigh less than seventy-five pounds. No stone or fragment shall be used that does not extend through the revetment.

(3) **Random Riprap. (a) General Requirements.** Stone shall be free from structural defects such as incipient fractures and seams and shall have given evidence of ability to withstand weathering after long exposure to the elements. Stone containing shale, unsound sandstone, or any other material which will readily disintegrate, shall not be used.

(b) **Type A.** At least eighty percent by weight of the stone or fragments shall have a volume of not less than one cubic foot or a weight of not less than one-hundred-fifty pounds.

(c) **Type B.** Not less than forty percent of the total volume shall be composed of stones having a volume of not less than four cubic feet with a minimum dimension of twelve inches and not more than twenty percent of the total volume may be composed of stones having a volume of less than one cubic foot with a minimum dimension of four inches.

(B) Construction Methods. (1) **Hand Laid Riprap.** A trench of the design and dimensions shown on the plans, and/or as directed by the engineer, shall be excavated along the toe of the slope to a stable foundation or carried to a point below scour, but in no case less than two feet below the toe of the slope and a course of the largest stone placed therein. The slope to be protected shall not be steeper than the angle of repose of the material, unless otherwise directed. The stones shall be placed with their beds at right angles to the slope and so far as practicable the larger stones shall be used in the

lower courses. They shall be laid in close contact so as to break joints and so placed that each stone will rest on the slope of the embankment and not wholly on the stone beneath it. The spaces between the larger stones shall be filled with spalls securely rammed into place. Ends of riprap walls shall be keyed into the earth or embankment slopes a minimum of twenty-four inches from the outer face of the riprap for the full height of the riprap wall. The finished work shall present an even, tight and reasonably plane surface, varying not more than three inches from the general contour of the revetment.

Where the thickness of the riprap is not shown on the plans it shall be at least twelve inches measured perpendicular to the slope.

(2) Random Riprap. The stone, graded so that the smaller stone is uniformly distributed throughout the mass, shall be handled or dumped on the designated slopes to form the cross section shown on the plans or as directed. The rock shall be manipulated by hand or machine methods sufficiently to secure a regular surface and mass stability. Where the thickness of the riprap is not shown on the plans it shall be at least eighteen inches measured perpendicular to the slope. Unless otherwise directed, riprap shall extend from two feet below the toe of the slope to mean high water elevation.

57.03 GROUTED RIPRAP. Except as hereby provided, "Grouted Riprap" shall conform to the specifications for "Hand Laid Riprap."

(A) Material. (1) Grout shall consist of one part of Portland cement and three parts of sand, thoroughly mixed with water to produce a mortar of a thick cream consistency. Mortar shall be used within thirty minutes after water is added and the mortar shall not be retempered.

(2) Mortar Sand shall conform to Article 46.04(C)(1), with the exception of the grading which shall conform to the following table:

Passing a No. 4 Sieve	100%
Passing a No. 8 Sieve	90-100%
Passing a No. 16 Sieve	60- 90%
Passing a No. 50 Sieve	15- 40%
Passing a No. 100 Sieve	0- 10%

(B) Construction Methods. The revetment shall not be less than nine inches in thickness. Care shall be taken to keep earth and sand from filling the spaces between the stones.

After the stone has been placed, the voids shall be filled with spalls or small stones in such manner that all stones are tightly wedged or keyed. The finished surface shall present an even, tight surface, with the plane not varying more than three inches from the general contour.

Following completion of laying all stone in the revetment and immediately preceding the placing of any grout, the surface shall be wetted with water. The crevices and openings shall be filled with mortar to a minimum depth of three inches, followed immediately by sweeping the surface with a stiff broom.

Grouting will not be permitted in freezing weather. When grouting is done in hot dry weather the work shall be protected by keeping it moist with water or a wet earth blanket for three days following its completion.

57.04 SACKED CONCRETE RIPRAP. **(A) Material.** The concrete, produced in an approved type mixer, shall consist of one part of Portland cement and ten parts of aggregate by volume. Pit run aggregate material complying with these specifications may be used. The amount of water added at the time of mixing shall be such as to result in a mixture with a three to five inch slump when tested in accordance with AASHTO T 119. Sacks shall be sound, ten ounce burlap sacks or equal, approximately eighteen inches wide by thirty inches long. If reclaimed, they shall not have contained any materials injurious to concrete. The aggregate shall consist of gravel and sand meeting the following grading requirements:

Passing a screen having 3-inch square openings.....	100%
Passing a screen having $\frac{1}{4}$ inch square openings.....	30- 50%
Passing a 100-mesh sieve, not more than.....	5%

Aggregate shall be free of organic matter or other deleterious substances.

(B) Construction Methods. Trenching preparation for sacked concrete riprap shall conform to Article 57.02.

The sacks shall be filled two-thirds with concrete and securely tied with heavy cord. Immediately upon filling, the sacks shall be placed by hand methods and kneaded into conformance with the trench and backslope or the adjacent sacks already in position. They shall be of uniform thickness along any cross section that is perpendicular to the longitudinal axis of the sack.

The first course of sacks shall consist of a single row of "stretchers" laid in the trench with the tied ends out. The second course shall consist of a single row of "headers" laid with the tied ends toward the earth slope. All succeeding courses shall be laid as "stretchers" with the tied ends out. All sacks shall be laid in "broken joints." Joints shall be staggered to pattern and firmly kneaded into position to form a good bond. All dirt and debris shall be removed from the top of the sacks before the succeeding course is placed.

Not more than five courses of sacks shall be placed in any tier until the initial set in the first course of any such tier has taken place. In placing, care in shaping the sacked concrete shall be exercised to obtain the minimum dimensions shown in the plans and to provide a minimum of voids. Sacked concrete

shall be kept moist as erection progresses and for a period of twenty-four hours following completion, by water sprinkling, moist earth covering or other satisfactory means.

57.05 METHOD OF MEASUREMENT. Hand-Laid, random, and sacked concrete riprap will be measured to the nearest one-tenth cubic yard of the completed and accepted riprap in place. "Concrete Slab Riprap" will be covered by plan requirements and special provisions for each case.

Grouted Riprap will be measured on the face of the revetment to the nearest one-tenth square yard of the completed and accepted riprap in place.

57.06 BASIS OF PAYMENT. Riprap will be paid for at the contract unit bid price, which price and payment shall be full compensation for The Work, including trench excavation unless otherwise specified.

When shown on the plans and stipulated in the proposal, trench excavation will be measured and paid for in accordance with Subsection 11.60.

SECTION 58

RUBBLE MASONRY

58.01 DESCRIPTION. "Rubble Masonry" shall consist of either "dry" or "cement" walls, as specified, composed of stones or quarried rock, constructed in conformity with the plans and specifications and/or as directed.

58.02 MATERIAL. Stone or rock shall be hard, sound, durable, free from rounded, worn or weathered surfaces, weak laminations or cleavages and clean of earth, clay or other foreign substances. It shall not have a wear exceeding forty percent at five-hundred revolutions as determined by AASHO Method T 96.

No stone or rock shall be used which has a thickness of less than five inches, or a width less than twelve inches, or which is less than one-half cubic foot in volume.

Mortar for cement rubble masonry shall conform to Section 57.

58.03 CONSTRUCTION METHODS. **(A) General.** All masonry shall be laid to line and in courses roughly leveled up. The bottom or foundation courses shall be composed of large selected stones and all courses shall be laid with bearing beds parallel to the natural bed of the material. The vertical joints in each course shall break joints with those in adjoining courses at least six inches. In no case shall a vertical joint be so located

as to occur directly above or below a header. Stones shall be so placed that they have firm bearing and will be well bonded.

Headers shall be distributed uniformly throughout the wall, so as to form approximately one-fifth of the exposed faces, and shall extend through the face wall and into the backing at least twelve inches. Where a wall is less than eighteen inches thick, the headers shall extend entirely through from front to back face. Where the wall is more than eighteen inches thick, the headers shall either extend entirely through or overlap at least six inches.

(B) Dry Rubble Masonry. In all cases the base thickness of the wall shall be at least half the height, which shall not exceed eight feet. The wall face shall be constructed with a batter of not less than one inch to one foot.

Dry Rubble Masonry shall be built up so as to leave no appreciable open spaces, and only sufficient spalls shall be used to wedge the stones into place. This class of masonry shall be finished with a top course or coping consisting of roughly shaped stones not less than six inches thick, from one and one-half to four feet long, and wide enough to cover the top of the wall, carefully laid in solid beds.

(C) Cement Rubble Masonry. All stones shall be thoroughly wet prior to laying and shall be fully bedded in mortar. Mortar which is not used within thirty minutes after water has been added shall be wasted. Retempering of mortar will not be permitted. Mortar shall be produced in a mixer of approved type.

The interior of the walls shall be built up so that the stones of which it is composed will be bonded and so that no open spaces will be left. Horizontal joints in the face shall not exceed one inch in thickness and vertical joints shall not exceed two inches in width. No spalls shall be used in the face of a wall, and the face stones shall be so well bedded that none will be needed. Walls shall be provided with weep holes wherever shown on the plans or as directed. If a stone is loosened after the mortar has set it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar.

Cement rubble masonry shall be finished with a concrete coping or with a top course consisting of roughly shaped stones. Copings, bridge seats, and backwalls, unless otherwise specified, shall be of Class "A" concrete as specified by Section 46, which shall be not less than eight inches thick and wide enough to cover the full width of the wall and shall be cast in place. If a stone coping is specified, the stones shall be not less than eight inches thick, from one-and-one-half to four feet long and wide enough to cover the top of the wall, set in full mortar beds as shown on the plans.

After the stone is all laid as specified the face joints shall be thoroughly cleaned of all mortar to a depth of one inch. The joints shall then be wetted and pointed with Portland cement

mortar mixed in the proportion of one part of cement to one part of sand.

No masonry shall be laid, or pointing done, in freezing weather nor when stone contains frost, unless otherwise directed. In hot or dry weather the masonry before and after pointing shall be satisfactorily protected from the sun and kept wet for a period of at least three days before completion. Any work damaged by frost or because of improper protection from the sun shall be removed and replaced at the contractor's expense.

58.04 METHOD OF MEASUREMENT. Rubble masonry will be measured to the nearest one-tenth cubic yard of the completed and accepted work, in accordance with plan dimension, unless otherwise directed.

58.05 BASIS OF PAYMENT. Rubble masonry will be paid for at the contract unit bid price which price and payment shall be full compensation for The Work.

Trench excavation, when shown on the plans and stipulated in the proposal, will be measured and paid for in accordance with the requirements of Subsection 11.60.

SECTION 59

HAND-LAID ROCK EMBANKMENT

59.01 DESCRIPTION. "Hand-Laid Rock Embankment" shall consist of strengthening embankments when slopes have been necessarily steepened, by the use of hand-laid rock placed as shown on the plans, in conformity with the specifications and as directed.

59.02 MATERIAL. The stone for this work shall be sound and durable, not less than one-half cubic foot in volume, and may be taken from the adjacent excavation.

59.03 CONSTRUCTION METHODS. An adequate footing shall be excavated in stable ground along the toe of the slope of the proposed fill. The selected stone material shall be placed by hand on this prepared footing and additional stone laid up to the width and dimensions directed. Care shall be taken to have the stones securely bedded and bonded. Spalls shall be used to fill voids. The hand-laid rock embankment thus constructed shall be backed by the usual embankment placed as prescribed under Subsection 11.80.

59.04 METHOD OF MEASUREMENT. Hand-laid rock embankment will be measured to the nearest cubic yard, or on a lump sum basis, of completed and accepted work. The excavation for the footing prescribed shall not be measured.

When rock material for this item is obtained from roadway or other prescribed excavation, no deduction from the excavation yardage for the stone so used shall be made.

59.05 BASIS OF PAYMENT. Hand-laid rock embankment will be paid for at the contract unit bid price, which price and payment shall be full compensation for The Work. If and when excavation for hand-laid rock embankment is a separate item it shall be covered by the provisions of Subsection 11.60.

SECTION 60

PIPE CULVERTS

60.01 DESCRIPTION. This specification describes the general requirements for all types, classes and designs of standard manufacture precast or prefabricated and structural plate culvert pipe, including the extension of existing culverts, except as may be modified or supplemented in any of the particular specifications for the respective pipe culverts specified. The exact types, classes, shapes, dimensions and locations for the culverts will be stipulated in the proposal, shown on the plans and designated by the engineer.

The locations and lengths of individual pipe culverts shown on the plans are approximate only and are subject to revision, as may be required, during the course of The Work.

60.02 MATERIALS AND MANUFACTURE. All culvert pipe used in the completed and accepted work shall conform to the requirements for materials and manufacture as set forth in the specifications for the particular type, class and design specified and shall have been tested according to the requirements and accepted for use, by the engineer, at the manufacturing source. Any pipe showing manufacturing or material defects which prevent proper installation or shows abuse or damage from improper handling in transit or on the job shall not be installed.

60.03 CONSTRUCTION METHODS. (A) Except as may be modified or supplemented by the proposal or plans for any of the respective types, classes or designs, all pipe shall be installed in accordance with the requirements of this specification.

(B) In the absence of specific requirements and plans for any particular installation of multiple lines of pipe, the culverts when fitted with aprons or flared end sections, shall be laid in such position that the ends of the aprons or flared end sections will form contact. Where installations with straight end sections are laid, the lines shall be separated by a distance of at least four (4) feet, but, not to exceed six (6) feet.

(C) Foundation Preparation—Reinforced Concrete Pipe.

The foundation for reinforced concrete pipe shall be prepared in accordance with Part (D) of this article unless the plans or special provisions specify that it shall be prepared in accordance with the provisions of this part. The foundation shall be either Class A, Class B, or Class C, as specified, as shown on the standard drawing. The foundation shall be prepared according to the lines and grades established by the engineer, with proper allowance made for camber. The entire foundation shall be of the required density and specified shape.

(D) Foundation Preparation. General. The foundation shall be prepared according to the lines and grades established by the engineer, with allowance being made for the required camber. Special care shall be exercised to attain a bed of uniform density when a backfill material is not used. The foundation shall be of required density and firm bearing ability throughout, and shall be carefully shaped to fit the lower part of the pipe for at least a minimum of 10% of its overall diameter. In the case of arch types the foundation shall conform to the full width of the slightly outward curved bottom not to include the smaller corners.

Where foundation preparation requires a trench it shall be excavated to width sufficient to permit thorough compaction of the backfill material around the pipe as hereinafter specified. Where the foundation, at the established grade, is unstable the material in the unstable areas shall be removed for a width of at least one (1) diameter (or span), but not exceeding six (6) feet, on each side of the pipe and the excavation backfilled with material as specified by Section 62.

When the trench is in solid rock, or other hard material, it shall be excavated to a depth of at least twelve (12) inches below the grade established for the bottom of the pipe. This additional excavation shall be backfilled with suitable material in such manner as to insure uniform bearing throughout. The foundation area shall be entirely free of protruding stones and other obstructional or undesirable matter.

All backfill material used in foundations beneath the outside diameter of the culvert shall conform to Section 62.

The foundation area, including any backfill, shall be compacted with mechanical tampers or suitable rolling equipment, in accordance with the requirements, including "density", of Article 11.84, except that each layer of material to be compacted shall not exceed a depth of four (4) inches of loose thickness.

Backfill material, when specified, shall be placed in accordance with the provisions of Article 60.05 for the particular pipe to be installed or as directed.

When the foundation area is composed principally of suitable granular type material for a sufficient depth the specified backfill material may be omitted, when directed.

No pipe shall be laid until the foundation has been approved by the engineer. Any pipe laid without prior approval of the foundation shall be removed and properly relaid at no additional cost to the State.

60.04 INSTALLATION. (A) Precast Rigid Pipe. (Reinforced concrete, concrete, tile, etc.) Unless otherwise directed, this type of pipe shall be laid on the foundation in standard section lengths, starting at the outlet end of the culvert, with the groove or bell ends upgrade, with all bell ends suitably recessed into the foundation.

The tongue or spigot end, as the case may be, of each section shall be forced into the respective groove or bell end to abut the end of the preceding section, to force the sections to a positively tight fitting joint. The sections shall be pulled together by winch and cable or similar equipment that will apply uniform pressure along the entire circumferential ends of the sections. The use of pry bars, jacks, bull-dozer or other makeshift equipment will not be permitted.

The joints of culverts used for irrigation, sewage, syphon or other purposes subjecting the installation to a continuous flow, or where infiltration might occur, (denoted on plan summary sheets under the heading "_____ RCP IRRIGATION") shall be sealed with (a) rubber type gaskets conforming to and installed in accordance with ASTM C 443 or (b) a flexible plastic joint sealing compound having the properties set forth as follows:

The sealing compound shall be produced from blends of refined hydrocarbon resins and plasticising materials reinforced with inert mineral filler and shall contain no solvents. It shall not depend on oxidizing, evaporating or chemical action for adhesive or cohesive strength. It shall be supplied in extruded rope-form of such cross-section and size as to adequately fill spaces between pipe sections. It shall be protected by a suitable removable two-piece wrapper so designed as to permit removing one half, longitudinally, without disturbing the other. Its composition and properties shall conform to those set forth below.

		Minimum	Maximum
Bitumen content	ASTM D 4	55	65
Ash-Inert Mineral Matter	AASHO T 111	35	45
Penetration	ASTM D 217 Cone		
32° F (300 gm) 60 sec		125	150
77° F (200 gm) 5 sec		50	60
115° F (150 gm) 5 sec		150	170
Softening Point	ASTM D 36	320°F	—
Specific Gravity at 77°F	ASTM D 71	1.25	1.35
Weight per gallon		10.4	11.25
Ductility at 77 (cm) min.	ASTM D 113	5.0	—
Flash Point c.o.c., °F	ASTM D 92	600	—
Fire Point c.o.c., °F	ASTM D 92	650	—
Volatile Matter	ASTM D 6	—	5

The joints of culverts used in normally dry installations may be sealed with either of the above gasket type materials or with a cement grout. When type (b), above, is used, one or more "ropes" shall be inserted in the joint, dependent upon tightness of fit. "Rope" for 12" to 24" pipe shall be approximately $\frac{3}{4}$ " size; for 27" to 42" pipe, shall be approximately 1" size; for 48" and larger pipe shall be approximately 1 $\frac{1}{2}$ " size. If cement grout is used, it shall be made up of one part Portland cement and two parts sand conforming to sand requirements of Article 57.03. The joints shall be thoroughly prewet and the grout placed onto the joint surfaces immediately prior to being forced together. If the joint is not completely filled after forcing together, additional grout shall be added to fill the joint level with the surface of the circumference. Cement grout, in these normally dry installations, shall be applied only to the upper half of the outside circumference and the lower half of the inside circumference with a two inch overlap on each side.

All concrete pipe joints shall be treated by one or more of the methods covered above—no installations shall be permitted without gasket or grout—except when open joints are so designated.

Pipe culverts for installations to operate under head or pressure will be especially designed and shown on the plans.

All angles, turns and branch connections shall be made with standard manufactured sections. All dead ends of sewers and branches shall be constructed with tightly closed ends or shall be closed with stoppers, of strength equal to the pipe, securely cemented in place.

Trenches in which any type sewers are to be constructed shall be kept as nearly dry as practicable at the time the pipe is placed or during the period that the joint filler material is setting.

(B) Prefabricated Flexible Pipe. (Corrugated Metal, Syphons, Etc.) The pipe shall be laid on the foundation with separate sections approximately one inch apart to cause mesh of corrugations with outside laps of circumferential joints pointing upgrade and with the longitudinal joints on the sides. The sections shall be connected with specified types of coupling bands firmly bolted. The coupling bands shall be tapped with a mallet or other suitable tool as they are tightened.

Pipe shall be so handled in laying as to prevent bruising, scaling or breaking of the spelter coating or other type of cover. In no case shall pipe be dropped or dragged in unloading.

Unless design and manufacture of the pipe has provided accordingly, all pipe forty-eight (48) inches in diameter and over, under fill cover twenty-five (25) feet or more in height, shall be elongated vertically approximately five (5) percent before any backfill is made. Field elongation shall be performed by strutting in accordance with standard drawings.

Field connections of syphon pipe will not be permitted within fifteen (15) feet of the centerline of the roadway.

Pipe culverts used for syphon, irrigation, sewage or other purposes subjecting the installation to a continuous flow, or where infiltration might occur, shall be close-riveted and soldered. Such culverts will be designated on the plan summary sheets under the heading ". . . CMP IRRIGATION". Field joints shall be made, in accordance with the following described method, to form positively watertight joints—A corrugated metal coupling band at least 12 inches wide, including attachments, shall be the basic connection. The band shall be tightened around the joint by means of the rods and nuts furnished with the band. The entire assembly shall conform to AASHO M 36. There shall also be furnished, with each coupling band, sufficient fibrous-asphalt compound of such consistency that it may be formed by hand in the field into asphalt "ropes" for filling the second corrugation on the end of each pipe section before the band is placed around the pipe, thus providing a watertight bond between the pipe and coupling band. Also to be furnished is a rubber gasket or other approved material, for insertion under the laps of the coupling band, when the head is 10 ft. to 20 ft. See Article 63.02.

(C) Structural Plate Types. All pipe of this type shall be erected on a foundation prepared in the manner specified, shaped to conform with the particular installation being made. Except as herein modified or supplemented, field erection shall be performed in accordance with the specifications furnished by the manufacturer or as stipulated in the proposal and shown on the plans. Erection shall not be started or proceed until the engineer and contractor have these specifications and instructions at the work site. No backfill shall be placed above the base until assembly of plates has been completed and all bolts in the structure have been tightened in accordance with specifications.

All bolts used in the erection of any type shall be tightened to a torque of one hundred seventy-five (175) foot pounds with a tolerance of plus or minus twenty-five (25) pounds. During the course of installation, the engineer will make sufficient tests of the tightened bolts to insure strict compliance with this requirement.

Strutting shall be accomplished in accordance with applicable standard drawings.

(D) Pipe Underdrains. All pipe installed for this purpose shall be laid in a trench excavated to the lines and grades shown on the plans or as established by the engineer. The bottom of the trench shall be shaped to accurately fit the pipe and shall be of sufficient dimension to permit placing of approved type aggregate backfill material. Unless otherwise provided, the pipe shall be laid in such manner that it is encased in a minimum of twelve (12) inches of aggregate backfill material, conforming to specified standard drawings covering underdrain backfill.

Perforated pipe shall be laid with the perforations down, unless otherwise directed. The earth backfill material shall be placed adjacent to the aggregate material and compacted in the

manner specified for foundation preparation under Part (C), Article 60.03.

(E) Rigid Type Underdrains. All underdrain pipe of this type shall be laid in the same manner as flexible type underdrains and according to the specifications for installation of surface drain pipe, except that the joints shall be left open with the spigot or tongue end kept a distance of $\frac{1}{2}$ inch from closure. All joints shall be wrapped with a 6 inch strip of 10 ounce burlap, one-and-one-half times around the joint, the lap providing double thickness on top of the joints.

60.05 BACKFILLING. (A) (All-Types.) Except as may be otherwise particularly specified for certain types of installation, all backfill material shall be uniformly placed over the entire culvert foundation area around the pipe in layers of not more than 4 inches loose thickness. The material adjacent to the pipe shall be free of sticks, stones, frozen lumps or clods and shall be handplaced and tamped in the same manner and to the same density as specified for foundation preparation. Particular care shall be exercised in uniformly and firmly tamping the backfill material under the haunches of the pipe.

Backfill in the rest of the foundation and adjacent embankment area shall be placed and compacted in the manner specified in Article 11.84, bringing the embankment up uniformly along and parallel to the entire length of the culvert. Placing of embankment over the pipe, in conjunction with overall grading operations, shall not proceed until the pipe has been covered to a depth equal to $\frac{1}{2}$ diameter of the pipe but in no case less than 2 feet of backfill material compacted in accordance with the method specified in Article 11.84. Heavy equipment shall not be allowed to operate over the culvert until that height of cover has been attained.

If the pipe has been laid in a trench, the trench shall be backfilled and tamped or otherwise compacted to the same density requirements specified in Article 11.88.

Backfilling around rigid type pipes that have been grouted shall not be performed until twenty-four hours after the grout has been placed.

Backfill and embankment shall be kept symmetrical on all sides of structures and their component members to avoid displacement and unbalanced stresses.

(B) Imperfect Trench Method. When reinforced concrete culverts are installed beneath an embankment, and the imperfect trench method of backfill is specified, backfill shall be performed according to the following described method:

A trench shall be excavated directly over the pipe for its full length and its width and depth shall be equal to the outside diameter of the pipe. It shall be neatly excavated with vertical sides. Machinery that will not accomplish this section will be prohibited and hand excavation called for if necessary. One foot of compacted material shall remain over the pipe.

The lower $\frac{1}{3}$ of the excavated ditch section shall then be filled with loose straw and then completely filled with loose highly compressible material. The embankment may then be constructed in the normal manner.

Excavation of the fill in the prism above the pipe will not be measured or paid for directly but shall be considered as a subsidiary obligation and necessary and incidental to installation of the culvert and included in the contract unit bid price for the pipe.

(C) Rock Embankment. In case the installation is to be under an embankment principally composed of blasted or fractured rock of varying dimension, the exposed surfaces of the pipe shall be encased with a minimum of 2 feet of compacted earth backfill material and the rock embankment material then placed around the pipe for an area equal to $\frac{1}{2}$ diameter, in accordance with the construction requirements set forth in Section 59. Excavation of the prism over the pipe, in cases of this kind, will not be required. Placing of earth backfill material and hand-laid rock embankment will not be measured or paid for separately, but will be considered incidental and necessary to the installation of the pipe and included in the contract unit bid price for the pipe.

60.06 METHOD OF MEASUREMENT. Pipe used in the completed and accepted work will be measured by the lineal foot. Pipe culvert, of all types, will be measured from end to end of the structure along the bottom or flow line. Measurement will include flared ends when installed, beveled, skewed and similar shapes or special designs.

Pipe installed in excess of the length ordered by the engineer will not be measured for payment.

60.07 BASIS OF PAYMENT. Pipe culverts and stockpasses will be paid for at the contract unit bid price, which price and payment, unless otherwise specified, shall be full compensation for furnishing and installing the pipe, hauling, handling, preparation of the pipe foundation, placing and compacting earth backfill material, furnishing the timber for and strutting the pipe when specified, and for all materials, mortar, coupling bands, bolts, fittings, labor, tools, equipment and for all incidentals necessary to complete the pipe installation.

Upon completion of the contract or when directed, the strutting shall be removed by the contractor at his own expense. If, in the judgment of the engineer, the strutting shall remain in place for a period beyond the contract acceptance date, it will be removed by State forces.

Should it be determined in construction that the length of any culvert or installation of pipe shown on the Plans is inadequate, then the contractor shall provide and place the additional length required at the contract unit bid prices for the appropriate type and dimension, including the furnishing and placing of additional coupling bands.

SECTION 61

REMOVE AND RELAY PIPE CULVERTS

61.01 DESCRIPTION. "Remove and Relay Pipe Culverts" shall consist of the removal of any type, class and dimension of pipe culvert from beneath the existing roadbed and from other locations shown on the plans, as directed. The work shall also include the cleaning, preserving and relaying of this pipe at locations, as directed or shown on the plans and storing of the pipe on the Project, as may be directed.

61.02 CONSTRUCTION METHODS. Excavation necessary for the removal of pipe culverts may be made by any method that does not involve injury to the pipe. Any pipe which, in the course of removal or handling, becomes bent, torn, crushed or otherwise damaged beyond reuse shall be replaced by the contractor with an equal length of pipe of the same diameter, of quality and condition equivalent to the condition of the damaged pipe prior to its removal. An old pipe culvert being relaid shall be cleaned, as thoroughly as practicable, of dirt, rubbish and other washed-in or blown-in materials prior to being relaid.

Backfill of the excavation occasioned by removal of any pipe culvert within the template section of the new roadway shall be performed in accordance with the requirements of Article 11.84.

Relying of pipe shall be performed in accordance with the pertinent requirements of Section 60.

61.03 METHOD OF MEASUREMENT. When stipulated in the proposal and shown on the plans removal of pipe culverts will be measured by the lineal foot of the completed and accepted work, in accordance with the pertinent requirements of Section 60. When shown on the plans, but not stipulated in the proposal, removal of pipe culverts will be considered subsidiary to the culvert excavation required of their removal.

Relay of pipe culverts will be measured by the lineal foot of the completed and accepted work, in accordance with the pertinent requirements of Section 60. The quantity is not guaranteed to be used or required and the engineer reserves the right to increase, decrease, or to omit all or any part of this item and no additional compensation will be allowed by reason thereof.

Excavation used in the removal of pipe culverts to be relaid and/or stored on the Project will be measured in accordance with the requirements of Subsection 11.60.

61.04 BASIS OF PAYMENT. Relay of pipe culverts will be paid for at the contract unit bid price, which price and payment shall be full compensation for removal, cleaning, preserving, cutting, handling, hauling, laying and/or storing any

of the various types, sizes, classes and dimensions of pipe removed, or pipe furnished in lieu of that removed; for the furnishing of any coupling bands, mortar and for all incidentals necessary to complete The Work.

Excavation required in the removal of pipe culverts to be relaid and/or in the relaying of the pipe will be paid for at the contract unit bid price for "Culvert Excavation", in accordance with Subsection 11.60.

The excavation work necessary for the removal of old culverts of the various types, irrespective of size, shall be measured and paid for as culvert excavation in accordance with the provisions of that subsection. All other work involved in removing the old culverts, including the removal of headwalls, shall not be paid for directly but shall be considered as subsidiary work pertaining to the roadway and drainage excavation items.

SECTION 62

BACKFILL MATERIAL FOR STRUCTURES

62.01 DESCRIPTION. "Backfill Material" shall consist of a course or courses of granular material, placed for structure and culvert foundations and backfill in accordance with the requirements of Section 60, and the plans and specifications or as directed.

62.02 MATERIAL. Backfill material shall be subject to the approval of the engineer. (a) It may be material commonly called "gravel". The material shall be uniformly graded, with a maximum size that will pass a 4 inch square opening and with at least 50% passing a No. 4 screen; however, the maximum size in the top three inches of the backfill material shall pass a 1½ inch square opening. (b) It may be material commonly called "sand". (c) It may be a combination of materials (a) and (b). The preferred material is "sand". See standard drawings. Regardless of the type of backfill material used, it shall be reasonably free of clay, silt or other unsuitable material. See Standard Drawings for backfill material for perforated and open joint drains.

62.03 CONSTRUCTION METHODS. Backfill material shall be placed in conformance with Section 60. See standard drawings.

62.04 METHOD OF MEASUREMENT. Backfill material shall be measured by the cubic yard as used in the completed and accepted work, compacted and complete in place.

62.05 BASIS OF PAYMENT. Backfill material shall be paid for at the contract unit bid price, which price and payment

shall be full compensation for The Work. While backfill material may not be specified by the plans, such an item may be included in the proposal as an arbitrary quantity for the purpose of providing a unit bid price for any quantity of backfill material that may be required. The quantity shown in the proposal, under such a condition, shall not be guaranteed to be required or used and The Commission reserves the right to increase, decrease or omit any or all of such items and no additional compensation will be allowed by reason thereof.

SECTION 63

CORRUGATED METAL PIPE CULVERTS

63.01 DESCRIPTION. "Corrugated Metal Pipe", conforming to these specifications and the requirements of Section 60, shall be furnished and installed as specified by the plans or specifications or as directed. All pipe covered by this section is round or elliptical.

63.02 MATERIALS AND MANUFACTURE. Corrugated metal pipe shall conform to the current requirements of AASHO M 36, except as those requirements may be supplemented or modified herein or by special provisions.

The seams and joints of corrugated metal syphon pipe shall be close riveted and soldered water tight, excepting that when the syphon pipe is to be bituminous treated the soldering shall be of a type that will withstand heat of asphaltic dipping. Connecting bands for syphon pipe, specially designed for the purpose, shall be at least 12" wide for 18" or smaller pipe and shall increase for larger sizes. The portion of pipe that will be covered by the connecting band shall be welded or riveted with flush-type rivet heads. This type of pipe shall, otherwise, conform to the requirements cited above. See Article 60.04(B).

Pipes designated to be furnished in elliptical form shall be formed and fabricated, at the plant or factory, 5% out of round to form an elliptical section. The vertical axis—the longer axis of the elliptical section—shall be clearly marked before shipping. All round pipe, 48 inches or more in diameter, shall be furnished in elliptical form. Elliptical pipe will not require strutting.

One end of the metal pipe "T" Sections as required for connection to median inlets shall be capped. The cap shall be constructed of metal equivalent to the pipe and fastened to the "T" section in such a manner as necessary to be water tight and develop a strength equivalent to the wall strength of the metal pipe.

When galvanized metal pipe culverts are required to be asbestos-bonded, bituminous coated or provided with a paved invert, such work and materials shall conform to Section 72.

63.03 CONSTRUCTION METHODS. Construction methods shall conform to Article 60.03.

The "T" sections named in the preceding article shall be placed on a very firmly compacted base with the fill below the invert firmly compacted to provide good bearing for the "T" sections and weight of riser pipe.

63.04 METHOD OF MEASUREMENT. Methods of measurement shall be as provided in Article 60.06.

63.05 BASIS OF PAYMENT. Payment shall be made in accordance with Article 60.07.

The length of "T" sections and riser pipe has been included in the total length of metal pipe. The unit price bid for corrugated metal pipe shall be construed to include the installation as required of the "T" sections and riser pipe.

This item will be listed in bid proposals as "CMP Culvert"; e.g. "24 inch CMP Culvert-16g".

SECTION 64

CORRUGATED METAL PIPE CULVERTS

ARCH TYPES

64.01 DESCRIPTION. "Corrugated Metal Pipe Arch Culverts", conforming to these specifications and the requirements of Section 60, shall be furnished and installed as specified by the plans and/or specifications or as directed.

64.02 MATERIALS AND MANUFACTURE. Corrugated metal pipe-arches, instead of being circular in form, shall be of a multi-centered form, with arch shaped top and slightly outward curved integral bottom, having a vertical diameter or rise which is approximately sixty percent of the horizontal diameter or span. Materials shall conform to the provisions of Article 63.02. Reference shall be made to plans and standard drawings concerning dimensional data, gage of metal, and other necessary information. Standard manufacturing practice concerning sheet sizes, lap, width of bands and weights per foot shall be followed unless specified otherwise. The minimum radius of any part of the pipe-arch section shall be four inches and, in any case, shall be sufficiently great to prevent damage to the spelter coating. The lapping longitudinal seams shall be factory riveted and shall be staggered so as to alternate on each side of the center of the top of the arch by approximately fifteen percent of the periphery.

When galvanized metal pipe-arch culverts are required to be asbestos-bonded, bituminous coated or provided with a paved invert, such work and materials shall conform to Section 72.

64.03 CONSTRUCTION METHODS. Construction methods shall conform, in general, to the requirements of Article 60.03. Strutting of pipe-arches will not be required, unless specified otherwise. Field joints shall be made from band couplers shaped to fit the formed pipe.

64.04 METHODS OF MEASUREMENT. Methods of measurement shall be as provided in Article 60.06.

64.05 BASIS OF PAYMENT. Payment shall be made in accordance with Article 60.07. The proposal will stipulate only the span dimension, to the nearest inch, of pipe-arch culverts in accordance with standard drawings for such culverts. The plans will carry both span and rise dimensions.

This item will be listed in bid proposals as "CMP Arch Culverts"; e.g. "29 inch CMP Arch Culvert-14g".

SECTION 65

STRUCTURAL PLATE PIPE CULVERTS AND STOCKPASSES

65.01 DESCRIPTION. "Structural Plate Pipe Culverts" and "Structural Plate Stockpasses" shall consist of furnishing and installations of such pipes, in conformity with the plans and specifications and the requirements of Section 60, except as may be herein provided or as may be directed by the engineer.

65.02 MATERIAL AND MANUFACTURE. (A) General. Structural plate pipe culverts, structural plate pipe-arch culverts and structural plate pipe stockpasses shall consist of curved sections of galvanized corrugated metal plate bolted together to form required shapes. The sizes and shapes of the plates shall be such that the finished structures will have the dimensions designated herein or on the plans. Materials for elliptical pipe culverts, pipe-arch culverts and stockpasses shall comply with the pertinent requirements of AASHO M 167.

Where structural plate pipe culverts, structural plate pipe-arch culverts or structural plate pipe stockpasses are already in place and called for on the plans to be lengthened, the new pipe extensions shall conform as nearly as practicable to the sectional shape of the existing pipe. Where the existing pipe has beveled ends, the beveled ends shall be removed, the new sections of culvert installed, and the beveled ends added thereto.

Unless otherwise called for on the plans, culverts and stockpasses shall have the ends step-beveled. Beveling shall commence at the bottom of the top plate and extend downward to the top of the corner plate on the slope indicated by the plans.

(B) Elliptical Structural Plate Pipe Culverts. Elliptical culverts shall be factory-formed with the vertical diameter elongated five percent from a true circle and the horizontal diameter decreased a corresponding amount to retain equal periphery. Installation shall be with the major axis vertical. If strutting is required, no additional vertical elongation will be necessary. The word "elliptical" will not be used in item descriptions for pipes specified under this section. However, the pipe is to be supplied in elliptical form.

(C) Structural Plate Stockpasses. Stockpasses shall be formed by plates forming a cross-section composed of five circular arcs and a flat-bottom tangent at their junctions and symmetrical about the vertical axis. A tolerance of four percent will be allowed for span and rise of stockpasses.

Periphery shall be formed by not less than six plates nor more than eight plates. Span and rise of stockpasses shall be either Design "A", or Design "B", as indicated on the plans or standard drawing.

Design "A" Stockpass. The top of the stockpass shall be an arc having a radius of not less than 26 inches or more than 30 inches and shall not be less than 100° or more than 130° . The sides shall be arcs having a radius of not less than 60 inches or more than 72 inches. Corners shall be arcs having a radius of not less than 17 inches or more than 20 inches. The bottom shall be a flat segment not less than 29 inches or more than 34 inches in width.

Design "B" Stockpass. The top of the stockpass shall be an arc having a radius of not less than 24 inches or more than 30 inches and shall not be less than 110° or more than 145° . The sides shall be arcs having a radius of not less than 85 inches or more than 112 inches. Corners shall be arcs having a radius of not less than 17 inches or more than 20 inches. The bottom shall be a flat segment not less than 29 inches or more than 34 inches in width.

65.03 HANDLING AND INSPECTION. The field inspection shall be made by the engineer, who shall be furnished by the seller with an itemized statement of the sizes and lengths of the plates in each shipment. This inspection shall include an examination of the culvert materials for deficiencies in the lengths of sheets used and any evidence of poor workmanship. The inspection may include taking of samples for chemical analysis and determination of weight of spelter coating. The plates making up the shipment shall fully meet the requirements of these specifications, and if twenty-five percent of the plates in any shipment fails to meet these requirements, the entire shipment may be rejected.

Plates shall be transported, unloaded and handled in such a manner that there will be no damage to the plates. Damage resulting from improper methods of transportation or handling shall be sufficient cause for rejection of the pipe.

65.04 CONSTRUCTION METHODS. Construction methods shall conform to Article 60.03.

65.05 METHOD OF MEASUREMENT. Methods of measurement shall be as provided in Article 60.06.

65.06 BASIS OF PAYMENT. Payment shall be made in accordance with Article 60.07.

“Structural Plate Pipe Culverts” will be abbreviated to “SPP Culverts” in bid proposals.

SECTION 66

STRUCTURAL PLATE PIPE—ARCH CULVERTS

66.01 DESCRIPTION. “Structural Plate Pipe—Arch Culverts” shall consist of the furnishing and installation of pipe-arches in conformity with the plans and with these specifications and the requirements of Section 60, except as may be herein supplemented, or modified.

66.02 MATERIAL AND MANUFACTURE. (A) General. The provisions of this paragraph are the same as those of Article 65.02(A).

(B) Structural Plate Pipe-Arch Culverts. Unless otherwise called for on the plans, end plates shall be beveled, as shown on plans, above the top of corner plate. See standard drawings. A tolerance of 4 percent will be allowed on span and rise of pipe-arches, providing the cross-sectional area is not substantially affected.

66.03 HANDLING AND INSPECTION. The provisions of this paragraph are the same as those of Article 65.03.

66.04 CONSTRUCTION METHODS. Construction methods shall conform to Article 60.03.

66.05 METHOD OF MEASUREMENT. Methods of measurement shall be as provided in Article 60.06.

66.06 BASIS OF PAYMENT. Payment shall be made in accordance with Article 60.07.

The proposal will stipulate only the span dimension, to the nearest inch, of pipe-arch culverts in accordance with standard drawings for such culverts. The plans will carry both span and rise dimensions.

“Structural Plate Pipe-Arch Culvert” will be abbreviated to “SPP Arch Culvert” in bid proposals.

SECTION 68

REINFORCED CONCRETE PIPE CULVERTS

68.01 DESCRIPTION. "Reinforced Concrete Pipe" conforming to these specifications, the plans and the requirements of Section 60, shall be furnished and installed as specified or as may be directed. This section includes such pipe used for sewer and underdrain purposes; the term "ordinary and drainage" purposes in Article 68.06 will include such use.

68.02 MATERIALS AND MANUFACTURE. (A) Reinforced concrete pipe shall conform to AASHO M 170 (ASTM C 76), except as those requirements are herein supplemented and/or modified.

(B) Reinforced concrete pipe furnished under these specifications shall be produced by a manufacturing plant for which the method of manufacture and quality of product have been approved by the engineer prior to the date of award of contract.

(C) The equipment and methods for controlling the proportions for the concrete, forming, and placing the reinforcement, the consolidation of the concrete in the molds, the protection and curing of the pipe, the molds, headers and pallets, shall be inspected and approved by the engineer prior to beginning fabrication.

(D) The use of elliptical reinforcement in circular pipe or round reinforcement in elliptical or arch pipe will not be permitted.

(E) The class of pipe culvert to be used will be shown on the plans and specified in the proposal form. When stipulated in the proposal and/or shown on the plans, flared end terminal sections shall be used. These sections may, at the option of the contractor, be precast standard sections or they may be cast in place in conformity with the design shown on the plans or current standard drawings. Attention is directed to Article 07.03.

(F) Type V cement shall be used where the foundation or backfill is alkaline, as designated by plans or special provisions.

(G) One end of the concrete pipe "T" sections as required for connection to median inlets shall be capped. The cap shall be constructed of reinforced concrete and fastened to the "T" section in such a manner as necessary to be water tight and to develop a strength equivalent to the wall strength of the concrete pipe. The riser part of the "T" section shall conform to Class III pipe, AASHO M 170.

(H) Flared-end terminal sections shall conform, as nearly as practicable within the limits of design, to Class III, AASHO M 170.

68.03 CONSTRUCTION METHODS. Construction methods shall conform to Article 60.03. The type of bedding for the culverts shall be designated by the plans or special provisions and will not be denoted in Item Number or Description.

The "T" sections shall be placed on a very firmly compacted base with the fill below the invert firmly compacted to provide good bearing for the "T" sections and weight of riser pipe.

68.04 METHOD OF MEASUREMENT. Methods of measurement shall be as provided in Article 60.06.

68.05 BASIS OF PAYMENT. Payment shall be made in accordance with Article 60.07.

The lengths of "T" sections and riser pipe has been included in the total length of concrete pipe. The unit price bid for reinforced concrete pipe shall be construed to include the installation as required of the "T" sections and riser pipe.

All pipe culverts under this section will be bid as "RCP culverts."

SECTION 69

REINFORCED CONCRETE ARCHES AND UNDERPASSES

69.01 DESCRIPTION. The materials and work covered by this section shall concern the furnishing and installation of reinforced concrete arch culverts, reinforced concrete underpasses, reinforced concrete stockpasses and any other similar prefabricated structures in conformity with the specifications, plans and the requirements of Section 60, or as may be directed.

69.02 MATERIALS AND MANUFACTURE. (A) The provisions of this article are the same as those in Article 68.02, except as modified herein.

The concrete, steel and design shall conform to applicable standard drawings (Series 69-). There will be no classes of concrete pipe as set forth by AASHO M 170.

(B) Design and manufacture of specified underpasses, stockpasses and similar structures shall conform to provisions set forth on the plans, current standard drawings or otherwise stipulated.

69.03 CONSTRUCTION METHODS. Construction methods shall conform to Article 60.03.

69.04 METHOD OF MEASUREMENT. Methods of measurement shall be as provided in Article 60.06.

69.05 BASIS OF PAYMENT. Payment shall be made in accordance with Article 60.07.

The proposal will stipulate only the span dimension, to the nearest inch, of pipe-arch culverts in accordance with standard drawings for such culverts. The plans will carry both span and rise dimensions.

All culverts under this section will be bid as "RCP Arch Culverts."

SECTION 70

UNDERDRAINS AND SEWERS

70.01 DESCRIPTION. "Underdrains and Sewers," or pipe, conforming to these specifications and the plans and the requirements of Section 60, shall be furnished as specified or as may be directed by the engineer.

70.02 MATERIALS AND MANUFACTURE. Tile or pipe shall be one of the following types or kind and shall conform to the respective requirements set forth, except as these requirements may be herein supplemented or modified.

- (A) Clay pipe shall conform to AASHO M 65.
- (B) Concrete drain tile shall conform to AASHO M 178.
- (C) Concrete sewer pipe shall conform to AASHO M 86.
- (D) Reinforced concrete sewer pipe. This type is specified under Section 68.
- (E) Corrugated metal pipe underdrains shall be perforated and conform to AASHO M 136, Type I or Type IV, unless specified otherwise.
- (F) Bituminized-Fibre Drain and Sewer Pipe shall conform to AASHO M 158.
- (G) Asbestos-Cement Non-pressure Sewer Pipe shall conform to ASTM C 428.
- (H) Clay drain tile shall conform to AASHO M 179.
- (I) Porous concrete pipe shall conform to AASHO M 176.
- (J) Perforated concrete drain pipe shall conform to AASHO M 175.
- (K) Perforated bituminized-fibre drainage pipe shall conform to AASHO M 177.
- (L) Perforated asbestos cement pipe for underdrainage shall conform to AASHO M 189.
- (M) When galvanized metal pipe culverts are required to be asbestos bonded, bituminous coated or provided with a

paved invert, such work and materials shall conform to Section 72.

(N) Asbestos-cement pressure pipe shall conform to ASTM C 296.

70.03 CONSTRUCTION METHODS. Construction methods shall conform to the requirements for the pertinent type described in Section 60, except that the backfill for corrugated metal pipe underdrains shall meet the requirements for fine aggregate specified in Article 46.04(C).

Where shown on the plans, the top surface of the backfill material shall be shaped as shown and sealed. The sealment may be clay or an artificial mixture composed of asphaltic bitumen or other binder, approved by the engineer.

70.04 METHODS OF MEASUREMENT. Methods of measurement shall be as provided in Article 60.06.

70.05 BASIS OF PAYMENT. Payment shall be made in accordance with Article 60.07.

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Clay Pipe. The plans will show the class of clay pipe to be used. Class 1, Standard Strength; Class 2, Extra Strength; Class 3, Standard Strength Perforated; Class 4, Extra Strength Perforated; Class 5, Cradle Invert.

Concrete Drain Tile. The plans will show the class of concrete drain tile to be used. Class 1, Standard Quality; Class 2, Extra Quality; Class 3, Special Quality.

Concrete Sewer Pipe. The plans will show the class of concrete sewer pipe to be used. Class 1, Standard Strength; Class 2, Extra Strength.

C.M.P. Underdrains. The plans will show the type of C.M.P. underdrain to be used. Type I, II, III and IV, as defined in M 136, will be specified as needed. The numbers 1, 2, 3 and 4 will be used instead of I, II, III and IV.

Bituminized-Fibre Drain Pipe. The name will be abbreviated to "Bituminized Fibre Pipe" when shown on plans and proposal.

Asbestos-Cement Non-Pressure Sewer Pipe. The name will be abbreviated to "Asbestos Sewer Pipe" when shown on proposal and shown in full on plans. Class 1, 1500; Class 2, 2400; Class 3, 3300; Class 4, 4000; Class 5, 5000; as per C 428.

Clay Drain Tile. The plans will show the class of clay drain tile to be used. Class 1, Standard; Class 2, Extra Quality; Class 3, Heavy Duty.

Perforated Concrete Pipe. The plans will show the class of perforated concrete pipe to be used. Class 1, Standard Strength; Class 2, Extra Strength. All non-reinforced.

Perforated Bituminous-Fibre Pipe. The name will be abbreviated to "Perforated Fibre Pipe" in plans and proposal.

The plans will show which is to be used: Type 1, Tapered Joints; Type 2, Square Ends; as shown in M 177.

Perforated Asbestos-Cement Pipe for Underdrainage. The name will be abbreviated to "Asbestos Drain Pipe" when used in plans and proposal.

Asbestos-Cement Pressure Pipe. The name will be abbreviated to Asbestos Pressure Pipe when shown on proposal and shown in full on plans. Class 1—100 psi; Class 2—150 psi; Class 3—200 psi.

The fifth digit of the item number shown in the proposal for the pipe will indicate the class or type named above, when there is classification.

SECTION 71

DITCH LINING, FLUME AND HEADGATES

71.01 DESCRIPTION. "Ditch Lining, Flume and Headgates" shall consist of the furnishing and erection of this type of structures in accordance with these requirements and the specifications and plans and/or as directed.

71.02 MATERIALS AND MANUFACTURE. (A) Metal ditch lining and metal flume shall be made of Gage 20 galvanized ferrous sheets and shall be of semi-circular type. The base metal and spelter coating shall comply with the physical and chemical requirements for corrugated metal culvert pipe as specified in Section 63. The completed flume or ditch lining shall consist of formed and beaded sheets, carrier rods, compression bars, shoes, anchor rods, nuts and washers, all of which shall be galvanized. The joints between successive sheets comprising the lining shall be designed to provide rigidity and water-tightness, and they shall offer the least possible resistance to flow.

Carrier rods, compression and anchor bars, shoes, nuts, washers and hanger plates shall have a galvanized coating of not less than three-fourths ounce of commercially pure zinc per square foot of surface. The coating shall be capable of withstanding three one-minute and one half-minute dips in a standard testing solution of copper sulfate without showing any trace of metallic copper on the steel, in accordance with AASHO T 66.

The lumber for framing shall conform to Article 51.02(B).

Use of the following listed species of wood will be allowed: Douglas Fir, West Coast Hemlock, Western Red Cedar, Ponderosa Pine, Larch, and Redwood.

(B) Timber ditch lining and timber flume shall be treated or untreated as specified in the plans and/or proposal and shall meet all the pertinent requirements of Section 43. When guide

posts are used in conjunction with "Ditch Lining" they shall conform to Article 90.41. Any required painting shall conform to Article 54.06(E)(2).

(C) Wood Headgate. Wood headgates for use in irrigation ditches shall conform to Standard Drawing.

(D) Concrete Headgate. Concrete headgates shall conform to special plans, drawings or special provisions.

(E) Metal Headgates. Metal headgates shall conform to special plans, drawings or special provisions.

71.03 CONSTRUCTION METHODS. The framing, erection and completion of the various structures shall be done in conformity with the appropriate provisions of Section 43 and in accordance with the plans and standard drawings.

Metal ditch lining and metal flume shall be laid true to line and grade, on a bed that is uniformly firm throughout its entire length. The separate sections shall be firmly jointed together with the outside laps of circumferential joints pointing upstream.

71.04 METHOD OF MEASUREMENT. Lumber used in the completed and accepted work will be measured in accordance with the respective requirements of Section 43.

Metal ditch lining and metal flume will be measured by the lineal foot of the completed and accepted work in place. When ditch lining is used in conjunction with guide posts, the posts will be measured under Section 90. Headgates of various types will be measured by the unit as installed.

71.05 BASIS OF PAYMENT. Lumber will be paid for at the contract unit bid price, which price and payment shall be full compensation for furnishing the lumber, hauling, handling, framing, erection, and all incidentals necessary to complete The Work.

When ditch lining is used in conjunction with guide posts the posts will be paid for under Section 90.

Metal ditch lining and metal flume will be paid for at the contract unit bid price, which price and payment shall be full compensation for The Work.

Headgates of various types will be paid for at the price bid for each, which price and payment will be compensation in full for The Work.

SECTION 72

BITUMINIZING OF METAL PIPE CULVERTS

72.01 DESCRIPTION. This section pertains to the coating or treatment of metal pipe culverts and structural plate pipe culverts with a coating of approved material in accordance with these specifications and the special provisions. The plans will indicate when bituminous-fibrous material is to be used; otherwise the coating material will be non-fibrous. The term "metal pipe culvert", as used hereinafter, shall include all types, forms and weights of metal pipe culverts. The treatment prescribed herein also shall be applicable to metal retaining walls and other facilities.

When such an item is stipulated in the proposal form it is meant that the item shall be furnished and installed in accordance with the plans and specifications as directed by the engineer.

72.02 MATERIALS. **(A) Basic Structure.** The metal pipe culverts and retaining walls to be treated, as prescribed in this section, shall conform to the applicable specifications as the case may be, or as may be modified by the special provisions.

(B) Bituminous Material. (1) Pipe culverts and other facilities which will be assembled at a factory or central plant shall be coated with material and in accordance with AASHO M 190. This will apply to Type A—Fully Bituminous Coated; Type B—Half Bituminous Paved Invert; Type C—Fully Bituminous Coated and Paved. (2) All structural plate pipe culverts, retaining walls and other facilities which must be protected by an application of bituminous material and which will be assembled at the construction site shall be treated with a bituminous-fibrous product which will pass the test requirements set forth in Article 72.04. The fibrous material shall be a combination of long fibre asbestos and carefully selected durable finely divided mineral fillers. This shall be designated Type D—Bituminized, regardless of the methods described under Article 72.03. The fibrous material shall pass the tests set forth in Article 72.04.

(C) Asbestos-Bonded. The galvanizing or spelter coating shall conform to the provisions of AASHO M 36 but shall be applied at such a rate per square foot, that, when sampled in accordance with specified methods, the recoverable amount of spelter, after the asbestos-bond has been removed, shall be not less than 1.5 ounces per square foot of double exposed surface. Asbestos-bonded metal pipe culverts shall be fabricated from asbestos-bonded sheets, the base metal of which shall conform to Section 63, or Section 70. Both sides of the metal sheets shall be coated with a layer of asbestos fibres applied by pressing a sheet of asbestos fibre into the molten metallic bonding medium. Immediately after the metallic bond has solidified, the

asbestos fibres shall be thoroughly impregnated with a bituminous saturant. The finished sheets shall be of first-class commercial quality, free from blisters and uncoated spots. After the asbestos-bonded sheets have been fabricated into culvert sections, the bituminous coating shall be applied in accordance with Article 72.03(1). This type of treatment will be designated as Type E—Asbestos-Bond.

72.03 APPLICATION. (1) Application and testing of bituminous material for Types A, B and C bituminizing shall conform to AASHO M 190. (2) Type D bituminizing shall be performed after assembly of the basic structure, in whole or in part. The facility shall be treated with a bituminous-fibrous product, as described in Article 72.02(B)(2) to a minimum thickness of 0.05 inch, over the entire outside and on the entire bottom one-third of the inside circumstance. Arch types shall be coated inside to the top of the corner radius. Measurement of thickness shall be made on the crest of corrugations. This also shall apply to the back or fill side of corrugated metal retaining walls.

The surface of the facility shall be thoroughly clean and dry, when the bituminous-fibrous material is applied. Air temperature at time of bituminizing must be at or above 50°F. and rising; however, if the temperature is 70°F. or higher, it need not be rising. The supplier or contractor may perform the bituminizing in any manner he may choose but the finished product must meet the test prescribed in Article 72.04 and be approved by the engineer.

72.04 SAMPLING AND TEST REQUIREMENTS—TYPE D.

(A) Sampling. All tests of bituminizing material shall be made on samples obtained from the vat or container immediately before application of the material. One or more 5 oz. samples shall be obtained and submitted to the engineer. Bituminous-fibrous material shall pass the tests set forth in Parts (B), (C), (D) and (E) of this article.

(B) Pliability and Adherence Test. Apply a coating of the material, approximately 1/16 inch thick, to a 22 gage degreased steel panel. After air drying for 48 hours, followed by baking in an oven for 48 hours at 220°F., the material shall not crack or peel from the panel when bent 180° over a $\frac{3}{8}$ inch mandrel, at a room temperature between 70°F. and 80°F.

(C) Flow Test. Spray and condition a coating of the material, as described in Part (B), with parallel lines spaced $\frac{1}{2}$ inch apart scored across the width of the surfaces. The panel shall be suspended in a vertical position, with the lines horizontal, in an oven at 320°F.-330°F. for 24 hours. Remove the panel and observe the surface of the coating for shifting or sagging of the lines. Any shifting or sagging of the lines shall be cause for rejection of the material.

(D) Acid and Alkalai Resistance Test. A coating of the material, prepared as described in Part (B), shall show no

signs or evidence of attack or deterioration when immersed for 24 hours in a 10 percent solution of hydrochloric acid, sulphuric acid or sodium hydroxide. On removal of the coating by solvent cleaning, the panel surface must be free of any pitting, rusting or other damage caused by the test.

(E) Water Vapor Permeability Test. The water vapor permeability of $\frac{1}{8}$ inch wet thickness shall be not over 0.0005 oz. (0.66 grains) per square foot per 24 hours under vapor pressure differential of 11.8 mm. of mercury at 22°C.

72.05 CONSTRUCTION METHODS. Construction and installation methods shall conform to Section 60. The pipe culvert or other facility shall be carefully inspected for abrasions and imperfections of the bituminous coating or treatment immediately prior to installation and backfill. Defects of a consequence, in the opinion of the engineer, shall be just cause for rejecting any sections of such facility. All bolt heads, nuts and exposed galvanized surfaces shall be thoroughly coated or treated, in all areas specified for treatment or coating, before installation is accepted.

72.06 METHOD OF MEASUREMENT. Method of measurement shall be as provided in Article 60.06.

72.07 BASIS OF PAYMENT. Payment will be made under the provisions of the Section with which the type of pipe culvert specified is concerned, e.g., bituminous treated corrugated metal pipe culvert will be covered by Section 63.

The types of coating or treatment, herein called bituminizing or bituminized for Types A, B, C, D and E shall be so designated in plans in full description and in the proposal in abbreviated description. The item in the proposal description will be similar to "36" Steel Pipe-14G-Type A Bitum.", with the item number, fifth digit, 1, 2, 3, 4 and 5 will represent A, B, C, D and E, in the plans "Fully Bituminous Coated-Type A".

SECTION 73

CONCRETE BOX CULVERTS

73.01 DESCRIPTION. Work and materials under this section shall consist of the furnishing of the necessary materials and the construction of concrete and masonry culverts, conforming to the lines, grades and dimensions given, and in accordance with the specifications for concrete and other items which are to constitute the completed structure.

73.02 MATERIALS. All materials used shall be those prescribed for the several items which constitute the structure.

73.03 METHOD OF CONSTRUCTION. All foundations shall be prepared as specified under Subsection 11.60, and they shall be inspected and approved by the engineer previous to placing any footing.

In general, the base slab or footings of box culverts shall be placed and allowed to set before the walls are constructed. Before concrete is placed in the walls, the footings shall be thoroughly cleaned of all shavings, sticks, sawdust, or other extraneous material and the surface carefully chipped and roughened in accordance with the method of bonding construction joints as specified under Paragraph (1) "Construction Joints," Article 46.05.

In the construction of box culverts 4 feet or less in height, the sidewalls and top slab may be constructed as monolith. When this method of construction is used, any necessary construction joints shall be vertical and at right angles to the axis of the culvert.

Each wing wall shall be constructed, if possible, as a monolith. Construction joints, where unavoidable, shall be horizontal and so located that no joint will be visible in the exposed face of the wing wall above the ground line.

Drains through all walls are to be placed as shown on plans or as directed by the engineer in the field.

73.04 METHOD OF MEASUREMENT. The quantities of the various items which constitute the completed and accepted structures shall be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing.

73.05 BASIS OF PAYMENT. The measured quantities as provided above shall be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for The Work.

SECTION 74

CURBS, GUTTERS, SIDEWALKS, HEADWALLS, ETC.

SUBSECTION 74.00 CURB AND GUTTER.

74.01 DESCRIPTION. "Curb and Gutter" shall consist of the construction of any of the types of curb, integral curb and gutter, median concrete curb and similar items and the furnishing and installing of precast concrete curb as stipulated in the proposal in accordance with these requirements and the plans, at those locations designated therein and as directed.

74.02 MATERIALS. When of Portland cement concrete, the materials shall conform to the requirements of Section 46; concrete shall be class "DD" unless specified otherwise. See applicable standard drawings.

Reinforcing steel shall conform to Section 47.

Materials for bituminous construction shall conform to Section 20 as regards aggregate and to Section 30 as regards bitumen. The bitumen shall be 60-70 Penetration Asphalt Cement. Powdered asphalt may be used to reduce (e.g.—85-100 to 60-70) a higher grade of asphalt cement to 60-70. The percentage of asphalt used shall be as directed within the limits of 6 and 8.5 percent. The aggregate shall meet the following gradation:

Sieve Sizes	Percentage Passing
¾"	100
½"	95-100
⅓"	85-100
No. 4	61-80
No. 10	38-57
No. 40	15-29
No. 200	3-10

74.03 CONSTRUCTION METHODS. Foundations for cast-in-place curb or curb and gutter shall be excavated or otherwise prepared in accordance with the pertinent requirements of Section 60.

Forms shall be either metal or straight grained finished lumber; in either case they shall be straight, free of warp or irregularities and of sufficient strength to resist springing or departure from true alignment and grade during the process of depositing of and following the placement of materials. Forms shall be full depth, securely staked and braced with headers and clamps. Contact surfaces of forms shall be clean and oiled to prevent adherence of materials and damage to surfaces in form removal.

The base on, or cavity in, which concrete is placed shall be thoroughly wet, but not muddy or showing pools of water, when the concrete is poured in place. Concrete shall be placed in the forms in uniform layers not to exceed six inches loose depth, with each layer being thoroughly tamped and spaded, with approved tools and methods, next to the forms during the placing process to assure uniform maximum density and a smooth surface.

As soon as concrete has set sufficiently to retain its shape, forms shall be removed and honey-combed or rough surfaces shall be immediately corrected by use of 1:2 mortar. The concrete shall be floated with a wooden float, applying clean water ahead of the float when required to form a slurry. All form marks and other irregularities shall be completely removed by floating. Final surface finish shall be obtained by uniformly brushing the surface, using an approved type brush before the concrete sets. The edges of all concrete, including edges at expansion joints, shall be neatly edged to the required radii.

Concrete shall be cured by keeping it wet with water or applying curing compound as specified in Article 39.02(O). If water is used, the concrete shall be kept wet for a period of seven days following its finishing.

The surface upon which the bituminous curb is to be placed shall be thoroughly cleaned and free of extraneous dust and foreign materials. It shall then be primed with diluted SS-1 emulsified asphalt at approximately 0.1 gal. per sq. yd. The mixture of bitumen and aggregate shall be mixed in an approved pugmill type mixer, at a temperature between 260°F. and 310°F. for not less than 40 seconds. The mixer shall have a capacity not less than 3 cubic feet. The aggregate shall be heated before mixing and shall contain not more than one percent moisture when placed in the mixer.

The mixture of bitumen and aggregate shall be uniformly fed to the extrusion or curb machine at a temperature which will avoid either sloughing of the material or tearing of the surface. The extrusion or curb mixture shall be forced through an orifice or plate by pressure. The machine shall be heated by ducting exhaust gases or heat from auxiliary burners over the surface of the orifice. The machine shall be mounted on skids to apply sufficient resistance to movement to properly compact the completed product. Any material which cannot be placed and compacted by the curb machine shall be compacted by mechanical tampers. Any required backfill shall be so placed as to not disturb the curb.

Slip forms or machines may be used on concrete structures, when approved by the engineer, provided these methods will secure a completed product comparable in all respects to that obtained by the set-form method.

When finished, all types of curb and integral curb and gutter shall present clean, uniform surfaces and lines free of irregularities or distortions. When tested with a ten foot straightedge, the alignment and grades shall not vary more than one-fourth ($\frac{1}{4}$) inch from the plane.

Precast curb shall be constructed of the class of concrete and in accordance with the requirements stipulated in the proposal or shown on the plans. Unless otherwise specified, precast curb shall conform to all the structural and finish requirements for cast-in-place curb. Precast curb shall be installed in accordance with the requirements shown on the plans and as directed.

74.04 METHOD OF MEASUREMENT. Curb, integral curb and gutter, median concrete curb and similar items will be measured by the lineal foot along the bottom of the curb line, including radii of completed and accepted work in place.

74.05 BASIS OF PAYMENT. Curb, integral curb and gutter, median concrete curb and similar items will be paid for at the contract unit bid price, which price and payment shall be full compensation for The Work. "Integral curb and gutter" will be bid as "curb and gutter."

SUBSECTION 74.50 CONCRETE SIDEWALK.

74.51 DESCRIPTION. "Concrete Sidewalk" shall consist of furnishing materials and constructing concrete sidewalks in conformity with the proposal, specifications, plans and standard drawings or as may be directed.

74.52 MATERIALS. The materials for Portland cement concrete sidewalks shall conform to Section 46. Concrete shall be Class "DD" unless specified otherwise.

Reinforcing steel, if used, shall conform to Section 47.

74.53 CONSTRUCTION METHODS. (A) **Subgrade and Forms.** Excavation shall be made to the required depth and thoroughly settled and compacted by wetting and tamping. All soft and unsuitable material shall be removed and replaced with acceptable material. When and as required by the plans, specified aggregates shall be placed and compacted to the required thickness. Forming shall conform to the pertinent requirements of Article 74.03 and Article 46.05. The contractor shall use suitable means to assure that grade lines are met and retained.

(B) **Concrete.** Concrete shall be prepared, mixed, placed, jointed, treated, cured and finished in accordance with the pertinent provisions of Article 46.05. Reinforcing steel, if used, shall be placed as specified by the plans. The base on, or cavity in, which concrete is placed shall be thoroughly wet, but not muddy or showing pools of water, when the concrete is poured in place.

74.54 METHODS OF MEASUREMENT. Concrete sidewalks shall be measured by the square yard of completed sidewalk. Reinforcing steel, if used, shall not be measured for payment.

74.55 BASIS OF PAYMENT. Payment for sidewalks will be made on the basis of the price bid per square yard. Payment for excavation of material not related to the construction of the sidewalk, but nevertheless necessary before the sidewalk can

be placed, when and if shown on the plans, will be made in accordance with the pertinent provisions of Section 11. Otherwise the contractor shall make all excavations, regardless of depth, required for constructing the sidewalk to the lines and grades shown or directed, and shall include all costs thereof in the unit price bid for the item. Payment at the price bid shall be full compensation for The Work.

SUBSECTION 74.60 CONCRETE HEADWALLS AND SUPPORTS.

74.61 DESCRIPTION. The Work contemplated under this subsection shall be the furnishing of materials and performance of work in connection with the construction of concrete headwalls, headgates and supports of various types, all in conformity with the proposal, plans, standard drawings, specifications and as may be directed.

74.62 MATERIALS. All concrete materials shall conform to the applicable requirements of Section 46. Concrete shall be Class "DD" unless specified otherwise. Reinforcing steel, if used, shall conform to the requirements of Section 47.

74.63 CONSTRUCTION METHODS. Excavation shall conform to the requirements of Section 60, insofar as applicable and as directed. Methods concerning installation and construction of concrete structures shall conform to the applicable requirements of Section 46. Reinforcing steel, if used, shall be placed as specified by the plans or standard drawings. The base on, or the cavity in, which concrete is placed shall be thoroughly wet, but not muddy or showing pools of water when the concrete is poured in place.

74.64 METHOD OF MEASUREMENT. Measurement of concrete shall be in accordance with the applicable provisions of Article 46.07. All measurements shall be by the cubic yard, to the nearest one tenth. If any reinforcing steel is used, it shall not be measured, unless specified otherwise and so provided in the proposal form.

74.65 BASIS OF PAYMENT. Payment for concrete shall be made in conformity with the applicable provisions of Article 46.08 at the price bid for the applicable items, which price and payment shall be full compensation for The Work. If any reinforcing steel is incorporated in the structures it shall be considered as being included in the price bid for the item, unless specified otherwise and so provided in the proposal form.

SUBSECTION 74.80 METAL CUTOFF WALLS.

74.81 DESCRIPTION. The work specified under this subsection shall consist of furnishing materials and performing all work in connection with the construction and installation of metal cutoff walls for pipe culverts, all in conformance with provisions contained in the proposal form, specifications and plans.

74.82 MATERIALS. The galvanized cutoff wall sheeting shall be fabricated from materials conforming to ASTM A 415, Hot Rolled Carbon Steel Sheets. A continuous 'U' type interlock, formed by bending the edge through 180°, shall be provided along both edges of each sheeting section. Sufficient space shall be left within the 'U' to permit free slippage of the adjoining sheet. The length of two jointed interlocks shall correspond to the length of the adjacent segment of the sheeting. The covering width of each sheet shall be 14 inches and shall have two corrugations 6 inches crest to crest and 2 inches deep. A tolerance of $\frac{1}{4}$ inch will be permitted. Lengths of sheets shall conform to stipulated standard drawings.

The sheeting shall be 10 gage for pipe diameters up to 9'6" and 8 gage for pipes of larger diameter. Each sheet shall be true, straight and uniform in section and shall be furnished with a pulling hole 1.5 inch diameter punched not more than 9 inches nor less than 6 inches from one end.

Deadmen used to hold sheeting in place shall be strips, of the above sheets, at least 12 inches in width and 6 feet long. Interlock feature will not be required. Deadmen shall be tied to the cutoff sheeting by $\frac{3}{4}$ inch diameter galvanized tie-rods conforming to ASTM A 307 and 1 $\frac{1}{4}$ inch diameter galvanized steel or iron washers. One end shall go through the deadman and the other through the sheeting cap.

The top of the cutoff wall shall be capped and reinforced by angle iron or unbalanced channel conforming to ASTM A 7. The cap shall cover at least 3 inches of the outside of the sheeting.

The cutoff wall sheeting shall be fastened to the metal pipe culvert by a curved metal plate, 6 inches wide and $\frac{1}{4}$ inch thick. The metal plate shall conform to ASTM A 7.

Bolts and nuts shall conform to AASHO M 167.

All materials shall be galvanized in accordance with ASTM A 93 or A 123, as applicable, at a rate not less than 2.0 oz. per square foot of surface.

Forming and shaping shall conform to applicable standard drawings or special plans when so provided.

74.83 CONSTRUCTION METHODS. Any required excavation shall conform to Section 60 insofar as applicable or as directed.

Sheeting shall be installed and placed where directed by the engineer or shown on the plans. It shall be held firmly in position and driven squarely and evenly by gravity or pneumatic equipment of sufficient size and weight to drive one or more sheeting sections at the same time without damage to the sheeting.

The sheeting shall be field cut to fit the structures or pipe. The metal plate specified in Article 74.82 shall be welded to the sheeting and then bolted to the pipe. Welding shall conform to Article 46.06(U).

The corrugated metal deadmen shall be driven where directed and tied to the sheeting and cap assembly.

The cap shall be firmly bolted in place atop the sheeting after it has been driven in place. If an unbalanced channel is used, the long side shall be on the out-side of the headwall.

Breaks, abrasions, damaged areas and cuts on metal components shall be thoroughly cleaned and then painted with zinc chromate primer and two coats of aluminum paint conforming to Article 54.05, Parts (B)(7) and (B)(3) respectively.

74.84 METHOD OF MEASUREMENT. Metal cutoff walls shall be measured by the square foot, to the nearest foot, of single surface, in place prior to cutting to fit the pipe structure.

74.85 BASIS OF PAYMENT. Metal cutoff walls shall be paid for at the price bid per square foot of headwall, which price and payment shall include materials and installation, deadmen, tie-rods, and all other hardware and operations needed to complete the installation.

SECTION 75

MANHOLES, INLETS, CATCH BASINS, COVERS, RISERS, ETC.

75.01 DESCRIPTION. "Manholes, Catch Basins, Inlets, Covers, Risers, Etc," shall consist of construction in place and the furnishing and installation of precast structures of any of the various types and designs of this classification in accordance with this specification and the requirements stipulated in the proposal and/or shown on the plans or standard drawings, at the locations designated therein and as directed.

75.02 MATERIALS. All materials used and any precast structures installed shall conform to the requirements stipulated in the proposal and/or shown on the plans. Concrete shall be Class "DD" unless specified otherwise. Reinforcing steel shall conform to Section 47.

75.03 CONSTRUCTION METHODS. Details of construction and installation of any structure will be stipulated in the proposal or shown on the plans.

Excavations shall be made to the required depth and the foundation or base upon which any structure is set shall be in accordance with the lines and grades established by the engineer. Foundations for the structures shall be prepared in such manner that the structure will have full contact and bearing of its base upon the foundation. Foundations shall be compacted in accordance with the density requirements set forth in Article 11.88.

Backfill of the excavation around the structure shall be of suitable material deposited uniformly around the structure in layers not to exceed four inches in depth with each layer being

compacted in accordance with the foregoing requirements for density. Extreme care shall be exercised throughout the back-filling process to maintain the structure to the established lines and grades. All structures, inlets, covers and other items specified by this section shall be constructed and installed in accordance with provisions set forth on applicable standard drawings.

Where mortar is required for making connections and for any other work necessary to any of the structures, it shall be composed of one part Portland cement to two parts sand meeting the requirements of fine aggregate set forth in Article 46.04 (C)(1).

The median inlet covers called for on the plans shall be constructed in accordance with the applicable Standard Drawing. The base for median inlet covers Type "C" shall be constructed of Class "DD" Concrete. The metal grates shall be constructed, as indicated on Standard Drawings of flat bar stock solidly welded as indicated.

The grates shall be thoroughly cleaned of scale and rust and then shop painted with one coat of red lead or zinc-chromate and two finish coats of aluminum paint, all conforming to Article 54.04 (B).

75.04 METHOD OF MEASUREMENT. Measurement will be made on the basis of any of the various structures as a unit of each structure or accessory completed and accepted in place.

75.05 BASIS OF PAYMENT. Manholes, Catch Basins, Inlets, Risers, Etc., will be paid for at the contract unit bid price, which price and payment shall be full compensation for The Work.

Median inlet covers shall be paid for at the unit price each, bid for the item, which payment shall constitute full compensation for the inlet covers completed in place. The price bid for concrete pipe shall be construed to include the materials and installation of riser sections.

SECTION 76

RETAINING WALLS

76.01 DESCRIPTION. Work under this section shall consist of the furnishing of the necessary materials and the construction of concrete or metal retaining walls conforming to the lines, grades and dimensions given, and in accordance with plans and specifications.

76.02 MATERIALS. (A) **C o n c r e t e R e t a i n i n g W a l l s.** Concrete, when required, shall be Class "DD", unless otherwise specified, conforming to Section 46. Reinforcing steel shall conform to Section 47.

(B) Metal Bin-Type Retaining Walls. Metal bin-type retaining walls shall consist of a plurality of pairs of columns, one column of each pair being in the plane of the front and the other column being in the plane of the rear of the wall, with the pairs of columns spaced longitudinally with overlapping S-shaped facing and rear members (stringer) and transversely with overlapping U-shaped tie members (spacers). The necessary bolts and appurtenances shall be furnished for complete assembly of the units into a continuous closed face wall of connected bins. The units in the structure shall conform to the dimensions shown on the plans. All metal sheets and plates shall be the gage shown on the plans but not less than Gage 16. Sheet metal for bin-type retaining walls shall be galvanized. The base metal, rivets, bolts, nuts, other hardware and galvanizing shall conform to the provisions of AASHO M 36; the base metal shall bear at least 0.2% copper. Any hardware not covered above shall be galvanized in accordance with ASTM A 153. All units shall be so fabricated that units of the same nominal size shall be fully interchangeable. No drilling, punching or drifting to correct defects in manufacture shall be permitted. Any units having holes improperly punched shall be replaced at no cost to the State. When bituminous treated walls are specified, treatment and handling shall be in conformity with Section 72.

76.03 CONSTRUCTION METHODS. **(A) Foundations.** All foundations shall be prepared as specified by Subsection 11.60, and they shall be inspected and approved by the engineer prior to placement of the structure. Concrete base slabs, when required, shall be placed and allowed to set before the superstructure is constructed.

(B) Concrete Retaining Walls. Dimensions, layout and details as shown on the plans shall be adhered to in all respects. Before concrete is placed in the walls, the footings shall be thoroughly cleaned of all shavings, sticks, sawdust, or other extraneous material and the surface carefully chipped and roughened in accordance with the method of bonding construction joints as specified by Article 46.05(I). Any necessary construction joints shall be vertical. Drains through all walls are to be placed as shown on plans or as directed by the engineer in the field. Dimensions and details shown on the plans shall be followed as required.

(C) Bin-Type Retaining Walls. The units and parts making up the walls shall be assembled to conform to the plans and the completed product shall present a neat, uniform, workman-like appearance. The ends of all stringers and spacers shall be securely bolted to corner columns by means of connecting channels. In the construction of a wall on a curve the proper curvature for the face shall be obtained by the use of shorter stringers in the front or rear panels of retaining walls as designated on plans or by the engineer. The wall height and depth may be varied, but not to exceed the maximum dimension shown for the design selected. Two or more designs of retaining walls

may be incorporated in the same wall by the use of standard split columns to make the connection on the step-back. The units shall be erected as shown on the plans. Members shall be handled carefully and any which are damaged shall be removed and new members substituted at the contractor's expense. Any members with damaged or broken spelter shall be rejected. When the walls have been bituminous treated, broken or damaged bituminous cover shall be painted with acceptable bitumen.

(D) Backfill. (1) Concrete Structures. Backfill shall be composed of material approved by the engineer and shall be placed as specified by Article 11.84.

(2) Metal Bin-Type Retaining Walls. Backfill outside the bins shall be made with material as excavated and used for construction of the roadway or as approved by the engineer. It shall be placed as specified above in (1). No separate and special payment shall be made for this backfill. Backfill inside and outside bins shall progress simultaneously. The inside of the bins shall be backfilled with material conforming to the provisions of Section 62. It shall be placed in layers not to exceed six inches in thickness. It shall be thoroughly compacted, using mechanical tampers, if so directed.

76.04 METHOD OF MEASUREMENT. **(A)** Concrete shall be measured in accordance with Article 46.07.

(B) Reinforcing steel shall be measured in accordance with Article 47.07.

(C) Excavation shall be measured in accordance with Article 11.63.

(D) Metal bin-type retaining walls shall be measured by the nominal square foot of facial area of wall.

(E) Backfill material shall be measured in accordance with Section 62.

76.05 BASIS OF PAYMENT. **(A)** Concrete shall be paid for in accordance with Article 46.08.

(B) Reinforcing Steel shall be paid for in accordance with Article 47.08.

(C) Excavation shall be paid for in accordance with Article 11.64.

(D) Metal bin-type retaining walls shall be paid for by the nominal square foot of facial area as bid, which price and payment shall be full compensation for The Work. This item will be bid as "metal retaining wall" or as "bituminized metal retaining wall" when treated in accordance with Section 72.

(E) Backfill material shall be paid for in accordance with Section 62.

SECTION 79

FARM FENCE

79.00 DESCRIPTION. Work under this specification shall consist of furnishing materials as needed, erecting and constructing new fence, moving existing fences, constructing and installing gates, moving cattle guards, and performing similar operations, all in conformity with specifications, plans, drawings, and other instructions. This type of fence is intended, primarily, for installation as a right-of-way consideration; may be used on Interstate between frontage road and other property or as temporary fence.

79.01 MATERIALS. (A) **General.** When the contract or plans specify a new fence, then all materials must be new and unused. When an existing fence is to be moved and/or reset, materials therefrom may be reused if acceptable to the engineer; any new materials anticipated to be required will be listed as bid items in the proposal. When the contract specifies the relocation of a fence, then any needed materials shall be new and of quality and type as near that of the old fence as is practicable. Any galvanized or galvanealed materials which bear serious abrasions or broken coating shall be rejected. See Article 79.04 for additional provisions. All posts for new fences shall be wood unless the special provisions specify otherwise. All galvanizing or galvanealing shall be Class I or heavier.

When the proposal calls for and lists bid items for new posts, new barbed wire or new woven wire, it applies only in those cases where an existing fence is being moved and reset. The item does not apply to materials for a new fence. When such items are bid in the proposal, they shall conform to the provisions of Article 79.01. A spool of barbed wire is 80 rods; a roll of woven wire is 20 rods. The price bid for any of these items shall include installation. Type F-2, F-3, F-4, F-5, and F-6 Farm Fence, and the attendant panels and gates, shall be constructed of new materials with the exception that deadmen may conform to part (J) below.

(B) **Woven Wire.** The woven wire mesh design shall be as specified or of height and mesh equal to the fence being moved. Woven wire shall conform to ASTM A 116, Class 1, and to Simplified Practice Recommendation R-9 as published by the U.S. Department of Commerce. If none is specified or being reused, then Design Number 726-12-12½ shall be used.

(C) **Barbed Wire.** Barbed wire shall conform to ASTM A 121, Class 1, and shall consist of two strands of Gage 12½ wire, twisted, with two point Gage 14 barbs, half-round or round, spaced approximately 4 inches apart. High-tensile strength, Gage 13½ wire, with Gage 14 barbs at 5 inch spacing will be accepted if the minimum tensile strength is 75,000 p.s.i.

(D) Brace Wire. Brace wire may be Gage 9, soft. It will be used for construction braces and panels, tieing to anchors, etc. A satisfactory substitute will be wire specified by Part (C)—Barbed Wire.

(E) Staples and Nails. The staples used to fasten the wire fencing to wooden posts shall be not less than Gage 9, 1½ inches long. Nails shall be of size approved by the engineer. Staples and nails shall be galvanized.

(F) Tie Wires. Tie wires shall be not lighter than Gage 12½. Used for fastening barbed and woven wire to metal posts, Commercial fasteners, supplied with the wire, may be used when approved. All shall be galvanized.

(G) Metal Fence Stays. These shall be of standard make, made from wire base, Gage 9½, twisted to form a 2-wire unit. Galvanizing shall be Class 1. Stays shall not be required unless so stipulated in the special provisions.

(H) Posts and Braces. **(1) General.** Posts and braces shall be wood unless specified otherwise in the special provisions.

(2) Wood Posts and Braces. Wood posts and braces may be lodge-pole pine, fir, larch, or cedar. Braces need not be treated with preservative, but all posts shall be treated and conform to the following provisions:

(a) Treatment. Wooden posts shall be treated with 5% pentachlorophenol preservative solution. Treatment must be done in such a manner and with a carrying agent that the preservative will penetrate the wood at least one-fourth inch. Treatment shall extend to a minimum length of thirty inches for line posts and thirty-six inches for other posts. The treated end shall be placed in the ground. Post treatment must be performed at a plant, approved by the Laboratory, where all operations and quantities can be closely controlled.

(b) Dimensions. Round line posts and braces must be at least 4 inch diameter at the smallest end (to determine diameter, divide circumference by 3.14): round posts for gates, corners, ends, and stretching must be at least 6 inch diameter at the smallest end (measured as above).

Four-sided posts must measure on each side within one inch of any of the other sides. Three-sided posts must measure on each side within two inches of any of the other sides. Regardless of number of sides, least cross-sectional area shall be 13 square inches for line posts and braces, and 29 square inches for corner, end, gate, and pull posts.

(c) Tapering. Posts that are to be driven into the ground shall be machine tapered to a dull point at the lower end. The upper end shall be tapered a distance of two to four inches along the end portion: this taper is not included in the specified post length. Tapering shall be done prior to treatment.

(3) Metal Posts and Braces. Metal line posts shall have a nominal weight of 1.33 pounds per foot, exclusive of anchor plate. They shall conform to Commercial standard 184, for steel fence posts, as published by the U. S. Department of Commerce. Line posts shall be Tee, H, Channel, or U-bar section and shall have corrugations, knobs, notches, holes or studs so placed and constructed as to engage a substantial number of fence line wires in proper position. Fastening wires to posts by punched tabs will not be acceptable. Each line post shall be provided with a steel anchor plate weighing not less than 0.67 pounds and welded or riveted to the post in a position to place its top edge about 2 or 3 inches below ground surface when the post is set to prescribed depth.

Metal posts and braces shall be painted in accordance with good manufacturing practice. Corner, end, gate or pull posts and braces shall be angle steel, $2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{4}''$ size, or heavier grade. Braces shall be $2'' \times 2'' \times 3/16''$ size or heavier. Quality shall be as prescribed for line posts.

Each corner, end, gate, or pull post and each brace shall be set in concrete and braced as indicated on the standard drawings.

When standard corner assemblies are to be used where the braces will be set about 180° apart, special brackets or clamps shall be supplied to fasten one brace to the post without interfering with the fence wire.

Metal pull or stretching panel may be made up of three line posts, with two acting as braces, securely fastened to the vertical member, all set in concrete. No more than two such panels shall be set in succession and such panels shall be no more than 330 feet apart.

(3) Lengths. Fence posts and braces shall be of the minimum lengths shown in the following table:

Kind of Post	Corner, End, Gate, Pull and Panel	Line	Brace
Metal	7'8"	7'0"	Commercial Standard
Wood	7'0"	6'6"	8 foot—approximate

(I) Gates. Metal gates shall be plain-top single drive standard farm gates of tubular steel frame with wire fabric filler. They shall be designed to fit openings, between gate posts, of the approximate widths called for by the plans. All gates shall be provided with one diagonal steel brace. Each gate shall be furnished complete with necessary hinges and latch and other hardware designed for use with the type of gate and gate post used on the project. All parts shall be galvanized.

Other gates for farm fences may be of the material and construction shown on Standard Drawings, or better. When

Types G-1 and G-2 gates are specified they shall conform to standard drawings.

(J) Deadman or Anchor. Deadmen or anchors will be used at grade depressions, angle points and other places where unusual stresses will be exerted on the fence. A deadman shall weigh at least 150 pounds and shall be buried in the ground with a cover of not less than 2 feet. A steel post set in concrete can serve as a deadman. It may be a precast Portland cement concrete block constructed in accordance with the standard drawing, or other object or thing satisfactory to the engineer. A deadman may be cast in place, when approved by the engineer. An anchor may be (a) a steel or iron bar or rod, for driving into the ground, at least $1\frac{1}{4}$ " diameter by 3 feet long, with provisions on one end so that a brace wire can be securely retained, or (b) a section of metal line post at least 3 feet long, or (c) a substitute satisfactory to the engineer.

(K) Concrete. Concrete used as footings for metal fence posts, braces and other similar purposes shall be a 1-2-4 mix, or better, satisfactory to the engineer.

(L) Cattle Guards. New cattle guards shall conform to Section 82 or as may be specified in plans or special provisions.

79.03 CONSTRUCTION METHODS. Post holes and excavations for footings and anchors shall be excavated on the lines established by the engineer and to the depths and cross-sections shown on the standard drawings. Wood posts may be driven when so prepared and any damaged posts shall be repaired or rejected. Metal posts which are not required to be set in concrete may be driven. All post hole filling and back-filling work shall be in thin layers and each layer shall be solidly tamped and compacted as it is placed. Posts and braces that are cut or trimmed for any valid reason shall be given two coats of preservative material approved by the engineer. (See first paragraph of Article 81.13.) Braces shall be securely nailed to terminal and brace posts.

Irregularities in the ground line upon which the fence is being constructed shall be corrected, as determined and directed by the engineer, by use of a bull-dozer or any other equipment that will perform a satisfactory job in the engineer's estimation.

All trees, shrubs, brush, rocks and other obstacles which interfere with proper construction of the fence shall be removed by the contractor and the materials so removed shall be disposed of in a manner satisfactory to the engineer.

A "run" of fence between pull posts shall not exceed 660 feet for woven wire less than 33 inches in height, nor 990 feet for barbed wire. Panels for stretching woven wire more than 33 inches in height shall be spaced not more than 330 feet apart. Changes in alignment of more than 30 degrees shall be considered to be corners and a double panel shall be installed

under such a condition. Panels shall be installed on curves as directed by the engineer.

Fence panels shall be set at the locations designed by the engineer. Post spacing shall be, normally, 16.5 feet, excepting panels. When wooden posts are specified for the fence, a metal line post shall be installed in each 500 foot run of fence, or one metal line post in a run of lesser length between end of gate posts, to serve as lightning protection. Holes in which concrete is to be placed shall be thoroughly wet when concrete is placed. When posts or braces are set in concrete the concrete must be fully set before fence wire is stretched in place or gates attached. Posts to be set in rock shall be placed in accordance with directions or approval of the engineer. After the posts, braces and footings have been firmly set and established, the woven wire and/or barbed wire shall be placed, tightly stretched and fastened to the posts.

Stretching by a motor vehicle will not be permitted; the power must be by or through a mechanical stretcher or device designed for such use. Stretching too tight is more detrimental than too loose.

Fence wire shall be wrapped around terminal posts and fastened to itself. Fence wire, in general, shall be placed on the side of the post opposite the roadway but on curves shall be placed so the force is against the post. The spacing of woven wire and barbed wire shall be as indicated on the applicable standard drawings. The fence shall be so constructed that (1) in the case of a barbed wire fence the bottom wire shall be no closer than 13 inches nor more than 18 inches from the ground; (2) woven wire shall not be on the ground nor more than 4 inches from natural or graded ground. At grade depressions and alignment angles, where stresses tending to pull posts from the ground are created, the wire fence shall be snubbed or guyed at the critical points by brace wire attached to each horizontal line of fence wire and the end of the combined strands being firmly attached to a "deadman" buried not less than 2 feet in the ground, or to an approved "anchor" at a point which will serve best to resist the pull of the wire fence. "Deadmen" also may be fastened to posts. When and where to use "deadmen" shall be decided or approved by the engineer.

When the proposal provides for moving and resetting a fence, all required materials, over and above those usable from the fence being moved, shall be new and conform to the provisions of Article 79.01. This provision is subject to modification by the special provisions and/or plans.

Fence being removed and not reset shall be handled as designated by the special provisions, plans, or engineer. When there are materials in such a fence that are worthy of salvage, as determined by the engineer, they shall be carefully handled and placed in stockpile within the confines of the project at locations designated by the engineer.

When the plans specify a temporary fence, to exist only during the construction of the project, such fence shall be

made of such materials and so constructed that it will keep livestock and man-made traffic off the confines of the road being constructed, to an extent satisfactory to the engineer. Such fences shall be removed when the permanent fence is built.

Additional fence wire may be used in some cases to fill depressions.

Staples shall be placed angling to the grain of the wood, at a slight downward angle, leaving a little free movement, and shall not be driven tight against the wire.

Gates shall be installed at the location called for by the plans, or by the engineer, in an acceptable manner.

A cross-fence, not the property of the State, shall not be fastened to the State's fence but shall be terminated, in a workmanlike manner, adjacent thereto, but not farther than 1 foot.

Upon completion, the fence shall be true to line and grade; all posts shall be vertical and firm and all wire shall be taut and the completed fence shall be completely acceptable in all respects; gates shall operate freely and properly; no openings shall be left that will permit stock or animals to pass through the fence.

79.04 DISPOSITION OF EXISTING FENCE. The bid item "move and reset farm fence" shall include furnishing all necessary equipment and doing all required work to move and reset an existing fence. The finished product shall be as near like the original fence as is practicable, including post type and spacing, wire type and spacing and other principle features. It shall be the intent that the fence, after being reset, is no better or no worse than the original, with the exception that rotten, broken posts and rusty, unusable wire shall not be reused but shall be replaced by new material as covered by bid items for new posts and new wire. The quantities of posts and/or wire specified in the proposal are estimated only and are inserted only for the purpose of establishing a price; the final quantities may be considerably more or less and any increase or decrease shall in no way affect the bid price.

The bid item "remove fence" shall include the satisfactory removal of all existing fences, when and as directed, regardless of type. The contractor may dispose of the materials in such fences in any manner satisfactory to the engineer, unless the plans or special provisions specify method of disposal. When the proposal provides for building new fence and there is material, in a fence being removed, that is acceptable to the engineer for reuse, then such material may be used in the new fence.

79.05 METHODS OF MEASUREMENT. (A) Measurement of wire fence shall be the number of lineal rods of completed fence, measured horizontally from outside to outside of gate

or end posts, exclusive of gates. If it is necessary, in crossing depressions to install a double section of fence, vertically, this extra section shall be measured for payment. Fence "moved and reset" or "removed" and temporary fence, shall be measured in the same way.

(B) Gates shall be measured by the lineal foot between gate posts.

(C) Wooden panels, as shown on the standard drawings, shall be made up of either one brace and two posts or two braces and three posts. Metal panels shall be made up of one post and either one or two braces.

(D) "Deadmen" will be measured by the number installed and accepted, when specified as a bid item. When not a bid item, they shall be installed when and where required by the engineer and no direct payment will be made for them. Anchors, as described in Article 79.01(J), will not be measured and paid for as "deadmen".

(E) Dozer time will be measured by the hour.

79.06 BASIS OF PAYMENT. (A) Wire fence shall be paid for on a lineal rod basis, measured as specified above, whether new, moved, or removed.

(B) Gates shall be paid for on a total lineal foot basis. When such an item is not included in the proposal, but is required, it shall be installed as directed but will not be measured for payment.

(C) Fence panels, as defined above shall be paid for on a unit basis commensurate with the bid item. When not a bid item, panels will be considered as part of the fence and bid as such.

(D) Deadmen will be paid for at the price bid for each deadman accepted in place. When not bid as such, no direct payment will be made.

(E) Use of dozer shall be paid for by the hour in conformity with Subsection 16.00.

Payment of the various items specified above shall be full compensation for furnishing all labor, materials, tools and equipment necessary or incidental to the construction of the complete fence and gates, including excavation, backfilling, anchors, tamping, concrete footings, miscellaneous hardware, clearing the line for the fence or cattle guards, and disposing of all debris—all to the satisfaction of the engineer.

79.07 TYPES AND ABBREVIATIONS. Wire fence and appurtenances shall be placed in several types for administrative and reference purposes. The types shall be as follows:

Wire Farm Fence _____ See Special Provisions

F2 Farm Fence _____ 2 barbed wires and 26" woven wire

F3	Farm Fence	3 barbed wires
F4	Farm Fence	4 barbed wires
F5	Farm Fence	5 barbed wires
F6	Farm Fence	47" woven wire and barbed wire
F2W	means wood posts; F2M mean metal posts	
Fence Panel		Any type described in Art. 79.04(C)
Deadmen		Any type described in Art. 79.01(J), anchors excepted

SECTION 80

CHAIN LINK FENCE

80.01 DESCRIPTION. "Chain Link Fence" shall consist of a chain link wire mesh fence, including gates, supported on pipe framework, furnished and constructed in accordance with these specifications, plans, current standard drawings (prefix number 80) and as directed by the engineer. Fence materials shall be steel or iron, or aluminum alloys, as will be specified. "Steel or iron" will be briefed to "steel" herein.

80.02 MATERIALS. (A) General. All material used in the construction shall conform to AASHO M 181. The fence fabric shall be Type 1—Zinc-Coated Steel, Type 2—Aluminum-Coated Steel, Type 3—Aluminum Alloy, as set forth in the proposal. The fifth digit of the item number corresponding to those above will be shown in the proposal, as well as the type in the item description. All materials shall be new and undamaged when installed. Imperfectly coated materials will be rejected.

Posts, rails, gate frames, expansion sleeves, wire ties, fabric ties, hog rings, tension wire, miscellaneous fittings and hardware furnished for use in conjunction with Type 1 or Type 2 fabric shall be of zinc-coated steel and those furnished for use in conjunction with Type 3 fabric shall be of aluminum alloy.

(B) Posts. (1) Steel. Line posts for 5' and 6' fence shall be 2 inch x 2 $\frac{1}{4}$ inch "H" column with nominal weight of 4.1 pounds per lineal foot; 3' and 4' fence shall be 1 $\frac{5}{8}$ inch x 1 $\frac{7}{8}$ inch "H" column with nominal weight of 2.80 lbs. per lineal foot. Gate posts shall be 3 $\frac{1}{2}$ inches nominal diameter pipe with nominal weight of 9.1 pounds per lineal foot. End, corner and "pull" posts (braced line posts) for 5' and 6' shall be 2 $\frac{1}{2}$ inches nominal diameter pipe with nominal weight of 5.79 pounds per lineal foot; for 3' and 4' fence shall be 2 inches nominal diameter with a nominal weight of 3.65 pounds per lineal foot. All posts shall be fitted with an approved top so designed as to fit securely over the post and carry the top rail or cable. The base of the top fitting shall carry an apron around the outside of the post. Length of post will be as shown on Standard Drawings.

(2) Aluminum. All posts shall conform to ASA schedule 40 with plain ends. Line posts shall be 2" diameter; end and corner posts 2½" diameter; gate posts shall conform to sizes shown in the following table:

A.S.A. Nominal Pipe Sizes Inches	Swing Gate Openings— Feet	
	Single Gate	Double Gate
2½	Up thru 6	Up thru 12
3½	7 thru 13	13 thru 26
6	14 thru 18	27 thru 36

Lengths shall be as shown on the standard drawing. Post tops shall be supplied for each post and be designed to carry the top rail or cable.

(C) Top Rails. **(1) Steel.** Top rails shall be pipe 1¼ inch nominal diameter, nominal weight 2.27 pounds per lineal foot, or 1½ inch x 1 5/16 inch "H" column, nominal weight 2.0 pounds per lineal foot. Couplings or expansion sleeves shall be outside sleeve type and at least seven inches long. One coupling in every five shall contain a heavy spring to take up expansion and contraction of the top rail.

(2) Aluminum. All rails shall conform to ASA schedule 40 pipe with plain ends and shall be 1¼ inch diameter. One coupling in every five shall contain a heavy spring to take up expansion and contraction of the top rail.

(D) Cable. **(1) Steel.** Top tension cable shall be ¾ inch diameter hot-dip galvanized 7-strand steel cable conforming to ASTM A 122, Common Grade. Galvanizing shall be Class "A".

(2) Aluminum. Cable will not be used on aluminum alloy fence. Use rail instead.

(E) Cable Attachments. Shoulder eye bolts shall be ½ inch diameter and of sufficient length to fasten to the type of posts used. Turnbuckles shall be of the shackle end type, ½ inch diameter, with standard takeup of 6 inches and provided with ⅜ inch diameter pins. Thimbles shall be light weight wire rope thimbles for use with ¾ inch diameter cable. Wire rope clips shall have a U-bolt diameter of 7/16 inch for use with ¾ inch diameter cable. Anchor shackles shall be ¾ inch diameter with a minimum distance between eyes of 11/16 inch and a pin diameter of 7/16 inch. Seizing shall be Gage 26 galvanized annealed iron wire.

(F) Braces and Truss Rods. **(1) Steel** Compression braces shall be the same type and size as the top rail. Tension truss rods shall be ¾ inch round rods with drop forged turnbuckles, or other approved type of adjustment.

(2) Aluminum. All rails shall conform to ASA schedule 40 pipe, with plain ends and shall be $1\frac{1}{4}$ " diameter. Truss rods shall be the same material, $\frac{3}{8}$ inch diameter. Brace rods shall be the same material, $\frac{1}{2}$ inch diameter.

(G) Vacant.

(H) Fence Fabric. (1) Steel. The fabric shall consist of Gage 11 wire for 3' and 4' fences and Gage 9 wire for 5' and 6' fences. It shall be woven into approximately 2-inch diamond mesh.

The width of the fabric shall be as specified or shown on current standard drawings. Chain link fabric shall be finished at top and bottom as shown on the standard drawing, with a "twisted and barbed" selvage. Barbing shall be done by cutting the wire on the bias.

(2) Aluminum. The fence fabric shall be wound and interwoven from Gage 11 wire for 3' and 4' fences and Gage 9 wire for 5' and 6' fences. The pickets shall form a continuous chain link fabric having 2 inch mesh. Top and bottom selvage shall be twisted and barbed.

(I) Fabric Bands and Stretcher Bars. (1) Steel. Fabric bands shall not be less than $\frac{1}{8}$ inch x $\frac{3}{4}$ inch in section and stretcher bars not less than $\frac{1}{4}$ inch x $\frac{3}{4}$ inch in sections.

(2) Aluminum. $\frac{1}{4}$ inch x $\frac{3}{4}$ inch flat stretcher bars with square edges shall be used on 3' and 4' fences; $\frac{1}{4}" \times 1"$ bars on 5' and 6' fence. Flat band fabric ties shall be about $\frac{1}{2}"$ wide by 0.060" thick.

(J) Tie Wire. (1) Steel. Tie wire for steel fence shall be Gage 9 iron wire. Hog ring fasteners shall be Gage 11.

(2) Aluminum. Tie wire shall be approximately Gage 9. Hog ring fasteners shall be about 0.110" diameter.

(K) Tension Wire. (1) Steel. Tension wire shall be Gage 7.

(2) Aluminum. Tension wire shall be approximately Gage 6.

(L) Gates. (1) Steel. Gate frames shall be constructed of pipe of sizes and weights shown below. The corners of the gate frame shall be fastened together and reinforced with a malleable iron fitting designed for the purpose, or they may be welded. Welding shall conform to Article 42.06(U).

Single Gate frame, 6 ft. and 8 ft. wide— $1\frac{1}{4}$ in. nom. dia. 2.27 lbs./ft.

Single Gate frame, over 8 ft. wide— $1\frac{1}{2}$ in. nom. dia. 2.72 lbs./ft.

Cross trussing shall be 3.8 inch galvanized iron adjustable rods.

Chain link fence fabric for filling the gate frame shall meet the requirements specified in Part (H) of this Article.

Each gate shall be furnished complete with necessary hinges, latch, and drop bar locking device designed for the type of gate posts and gate used on the Project.

Gates with frames constructed of steel sections, other than the pipe specified above and fabricated in such a manner as to form a gate of equal or better rigidity, may be used provided they are approved by the engineer.

(2) Aluminum. Gates frames shall be fabricated from 1½" A.S.A. schedule 40 pipe, assembled by welding with I.G. 4043 electrode and/or fittings. An acceptable alternate may be made from galvanized malleable iron. Hinges shall conform to above for fittings. Locking devices may be galvanized malleable iron or steel; plunger bars may be tubular or bar steel.

Gate sizes shall be as specified with the height conforming to the height of fence. Other general provisions prescribed for steel gates shall apply to aluminum gates.

80.03 CONSTRUCTION METHODS. **(A) Posts.** Posts shall be spaced at not more than 10-foot intervals. All intervals shall be measured center to center of posts. In general, in determining the post spacing, measurement will be made parallel to the slope of the existing ground and all posts shall be placed in a vertical position except where designated otherwise by the engineer.

All posts on 5 ft. and 6 ft. fence, and the end posts, anchor line posts and pull posts on 3 ft. and 4 ft. shall be set in Class "F" concrete (Section 46) to the dimensions shown on standard drawings. Holes for concrete shall be thoroughly wet just before concrete is placed. All concrete footings shall be crowned so as to shed water. Line posts, except anchor line posts on 3' and 4' fence shall be set in solid earth, either by driving or drilling. Driving shall be accomplished in such a manner as not to damage the post. Any voids around the post shall be backfilled with suitable material and thoroughly tamped.

Where solid rock is encountered without an overburden of soil, line posts shall be set a minimum depth of 14 inches, and end corner, gate and pull posts a minimum of 20 inches into the solid rock. The hole shall have a minimum width or diameter of one inch greater than the largest dimension of the post section to be set. The posts shall be cut, before installation, to lengths which will give the required length of post above ground, or if the contractor so elects he may use an even length of post set at greater depth into the solid rock. Not more than two successive shortened posts shall be set. The third must be full length.

After the post is set and plumbed the hole shall be filled with grout consisting of one part Portland cement and three parts clean, well graded sand. The grout shall be thoroughly worked into the hole so as to leave no voids. Where posts are set in the above manner, concrete footings will not be required.

Where solid rock is covered by an overburden of soil or loose rock, the posts shall be set to the full depth shown on the standard drawing unless the penetration into solid rock reaches the minimum depths specified above, in which case the depth of penetration may be terminated. Concrete footings shall be constructed from the solid rock to the top of the ground on 5 ft. and 6 ft. fence and on end, pull and anchor line posts on 3' and 4' fence. Grouting will be required on the portion of the posts in solid rock.

"Pull posts" as used in these specifications shall be line posts braced to adjacent line posts in the manner shown on the standard drawing and spaced at 500-foot maximum intervals.

End, gate, and pull posts shall be braced to the adjacent line post, and corner and pull posts to the two adjacent line posts in the manner shown on the standard drawing. Changes in line of 30 degrees or more shall be considered as corners.

Irregularities in the ground line upon which the fence is being built shall be corrected, as determined and directed by the engineer, by use of a bulldozer or any other equipment that will perform a satisfactory job in the engineer's estimation.

(B) Top Rail—6 Foot Fence. Top rails shall pass through the ornamental tops of line posts, forming a continuous brace from end to end of each stretch of fence. Lengths of top rail shall be jointed by sleeve type couplings. Top rails shall be securely fastened to terminal posts by pressed steel fittings.

(C) Top Tension Cable—3, 4 and 5 Foot Fence. Top tension cable shall pass through the ornamental top of the line posts. One continuous length of cable shall be used between pull posts. The cable shall pass through the pull post top and down to the base of the next line post where it shall be attached to the base of the line post with a turnbuckle in the manner shown on the standard drawing. Sufficient tension shall be applied to the cable to allow a maximum sag of $\frac{1}{4}$ inch between posts after the chain link mesh has been attached to the cable. The contractor shall provide temporary bracing on pull posts when applying tension to one length of cable at a time, to prevent undue stresses in the pull post.

After tension has been applied to the cables, a wire rope clip shall be placed around both cables, one on each side of the pull posts, and the clips securely tightened. Clips shall be placed as close to the posts as possible to minimize the deflection of the post if one of the cables should be parted.

The cable shall be fastened to the top of the end pull post with an eye-bolt through the post and a turnbuckle connecting the eye-bolt to the cable. The end pull post shall be braced to the bottom of the end post with a short length of cable attached as shown on the standard drawing. A length of cable shall connect the end pull post and the end post at the top shall be connected to the posts as shown on the standard drawing.

Eye-bolts shall have a shoulder on the eye end and shall be provided with a nut and lock washer. Where the eye-bolt is to be installed through a pipe section, two lead washers shall be placed against the shoulder of the eye, and a lead washer backed and the nut tightened sufficient to seal the hole in the pipe.

A galvanized iron strap $\frac{1}{4}$ inch in thickness by 2 inches in width, formed as shown on the standard drawing, shall be provided for the attachment of eye-bolts to the base of the "H" column post in order to take the strain of the cable tension off the web of the "H" column.

All holes drilled in the post sections shall be cleaned and painted, as hereinafter specified in Part (F) for welded areas on gates, before the eye-bolts are installed.

The ends of all cables shall be seized with annealed iron wire passed around the end of cable and the line cable as shown on the standard drawing. The seizing shall be at least one inch in width.

(D) Fence Fabric. Chain link fabric on 6 ft. fence shall be placed on the face of the post away from the Highway, and on 3', 4' and 5' fence on the face of the posts designated by the engineer, except that on curves the fabric on all types of fence shall be placed on the face of the post which is on the outside of the curve.

The chain link fabric on 6' fence shall be placed approximately 1 inch above the ground and on a straight grade between posts by excavating high points of ground. Filling of depressions will be permitted only upon approval of the engineer. The fabric on 3', 4' and 5' fence shall be placed above the ground at the height shown on standard drawings.

The fabric shall be stretched taut and securely fastened to the posts. Stretching by motor vehicle will not be permitted. Fastening to end, gate, corner, and pull posts shall be with stretcher bars and fabric bands spaced at one foot intervals. The fabric shall be cut and each span attached independently at all pull and corner posts. Fastening to line posts shall be with tie wire, metal bands or other approved method, attached at 14-inch intervals. The top edge of the fabric shall be fastened to the top rail with tie wires spaced at 18-inch intervals, or to the top tension cable with tie wires placed at 30-inch intervals.

Rolls of wire fabric shall be joined by weaving a single strand into the ends of the rolls to form a continuous mesh.

If, and when a cattle guard with wings is placed in a line of chain link fence, the wire fabric shall be extended beyond the post supporting the wing to the wing in a neat, workmanlike manner, and securely fastened thereto to the satisfaction of the engineer.

(E) Tension Wire. A tension wire shall be attached to the bottom of the chain link fabric by means of hog ring fasteners

at a maximum of 24" intervals and secured at the terminal posts or pull posts by means of brace bands.

(F) Gates. Chain link fabric shall be fastened to the end bars of the gate frame by stretcher bars and fabric bands, and to the top and bottom bars of the gate frames by tie wires in the same manner as specified hereinbefore for the chain link fence fabric; or by other standard methods if approved by the engineer.

Welded connections on steel gate frames, where the spelter coating has been burned, shall be thoroughly cleaned by wire brushing and all traces of the welding flux and loose or cracked spelter removed. The clean areas shall then be painted with two coats of zinc oxide-zinc dust paint compound in a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.

The drop bar locking device for the double metal gates shall be provided with a 12-inch square by 15-inch deep footing of Class "F" concrete, crowned at the top and provided with a hole to receive the locking bar. The depth of the penetration of the locking bar into the footing shall be as specified by the manufacturer of the locking device.

The height of the gate frame shall be approximately as follows:

6' Fence — 5'6"	3' Fence — 3'6"
5' Fence — 4'6"	4' Fence — 3'6"

(G) Panels. Panels, made up as described below, shall be installed where indicated by the plans or as directed by the engineer. The final quantity may vary considerably from plan quantities and the contractor agrees to furnish and install any final quantity at the bid price, whether more or less than planned. Double panels, such as may be used at fence corners and angle points, will be composed of, approximately, on corner post, two line posts, brace, truss rod, concrete and other miscellaneous fixtures. Single panels such as may be used at gates and fence ends, will be composed of, approximately, one gate or end post, one line post, brace, truss rod, concrete and miscellaneous fixtures.

80.04 METHOD OF MEASUREMENT. Chain link fence will be measured, approximately parallel to the ground, by the lineal foot of completed fence, exclusive of openings.

Gates shall be measured for length as the horizontal distance between the inside faces of the two gate posts. Gate types are as follows: 6 ft.—5'6" high; 5 ft.—4'6" high; 3 ft.—3'6" high.

Single and/or double panels, as described in Part (G) of Article 80.03, will be measured by the unit as installed and accepted when and if panels are a bid item in the proposal. The fence fabric will be measured as part of the fence.

Cattle guards shall be paid for on a unit basis, as indicated in the proposal form and in Section 82.

Dozer time will be measured by the hour. Equipment and operation shall conform to Subsection 16.00. Dozer time is to be used in preparing the fence line for building the fence. Any other equipment that will produce equal results will be permitted and paid for as dozer time.

80.05 BASIS OF PAYMENT. Payment for the various items listed below shall be full compensation for furnishing all labor, materials, tools and equipment necessary or incidental to the construction of the completed fence and gates, including excavation, backfilling, tamping, concrete footings, smoothing irregularities in the ground along the fence line, clearing the line and disposing of debris—all to the satisfaction of the engineer. Cattle guards will be paid for under Section 82.

Gates will be paid for by the foot as installed

Single and double panels will be paid for per each as bid.

Use of dozer will be paid for by the hour in conformity with Subsection 16.00.

SECTION 81 WIRE FENCE

81.11 DESCRIPTION. "Wire Fence" shall consist of furnishing materials for and erection and construction of wire fences and gates in accordance with plans, specifications and standard drawings, or as directed by the engineer. Wire fence shall be of barbed wire or barbed wire combined with wire mesh, fastened to posts. A metal gate shall consist of a metal frame filled with wire mesh. This type of fence is designed primarily for use on the Interstate System.

81.12 MATERIALS. (A) General. All materials used in the construction of the fence and gates shall be new and unused. All metal material shall be galvanized uniformly. Imperfectly galvanized material, or material upon which serious abrasions of galvanizing occur, shall not be used. The type of posts to be used shall be indicated by the proposal.

(B) Woven Wire. The woven wire mesh design shall conform to Design Number 832-6-11, No. 11 Farm Fence, as shown in Table II of the Appendix to ASTM A 116, wherein the height is 32 inches; 8 horizontal wires with top and bottom wires Gage 9 and intermediate wires Gage 11, stays Gage 11 spaced at 6 inches. Woven wire fabric shall conform to ASTM A 116, Class 3.

(C) Barbed Wire. Barbed wire shall conform to ASTM A 121, Class 3, and shall consist of two strands of Gage 12½ wire,

twisted, with four-point Gage 14 barbs, half round or round wire, spaced not more than five inches apart.

(D) Brace Wire. Brace wire may be Gage 9, soft. It will be used for constructing braces and panels, tieing to anchors, etc. A satisfactory substitute will be the wire specified by Part (C)—Barbed Wire.

(E) Staples and Nails. The staples used to fasten the wire fencing to wooden posts shall be not less than Gage 9, 1½ inches long. Staples and nails shall be galvanized.

(F) Tie Wires. Tie wires shall be not lighter than Gage 12½, galvanized. Used for fastening barbed and woven wire to metal posts.

(G) Metal Fence Stays. These shall be of standard make, made from wire base, Gage 9½, twisted to form a 2-wire unit. Twenty-four inch stays, one between 2 line posts, shall be used on Type CW and CM fence.

(H) Metal Fence Posts and Braces. Corner, end, gate or pull posts, and braces shall be angle steel. Angle steel posts shall be 2½"x2½"x¼" size, or heavier grade. Braces shall be 2"x2"x3/16" size, or heavier, finished like the posts. The metal shall be a good commercial quality steel with maximum carbon content of 0.82 percent. Material conforming to commercial standard CS 184 will be accepted.

Pull panels may be made up of three line posts, with two acting as braces, securely fastened to the vertical member, all set in concrete. No more than three such panels shall be set in succession and such panels shall be no more than 330 feet apart.

All corner, end, gate, or pull posts used in constructing a specified type of fence on the Project shall be of the same type, other than cited in the above paragraph. When standard corner assemblies are to be used where the braces will be set about 90° to 180° apart, special brackets or clamps shall be supplied to fasten one brace to the post without interfering with the fence wire.

Each corner, end, gate, or pull post and each brace shall be set in concrete and braced as indicated on the standard drawings.

Line posts shall have a nominal weight of 1.33 pounds per foot, exclusive of anchor plate. They shall conform to Commercial Standard 184, for steel fence posts, as published by the U. S. Department of Commerce. Line posts shall be Tee, H, Channel or U-bar section and shall have corrugations, knobs, notches, holes or studs so placed and constructed as to engage a substantial number of fence line wires in proper position. Posts with punched tabs for fastening wires are not acceptable. Each line post shall be provided with a steel anchor plate weighing not less than 0.67 pound and welded or riveted to the

post in a position to place its top edge about 2 or 3 inches below ground surface when the post is set to prescribed depth.

All posts, braces, anchor plates and fittings shall be galvanized in accordance with ASTM A 123 or A 153.

Fence posts and braces shall be of the lengths set forth in Table A — Post Lengths.

TABLE A — POST LENGTHS

Fence	Type	Corner, End, Gate, Pull & Panel Posts	Line Posts	Brace and Brace Rail
CM	Metal	7' 8"	7' 0"	7' 8"
CW	Wood	7' 6"	7' 0"	8' 0"

(I) Wood Fence Posts and Brace Rails. Posts and brace rails for type CW fence shall be made from Western Larch, Lodgepole Pine, Ponderosa Pine, Douglas Fir, Western Red Cedar, or equivalent product. They shall have the bark removed, be well seasoned, sound, and straight-grained. They shall be finished either natural round or square sawn.

Line posts shall be four inch minimum diameter, naturally round, or a minimum of four inch by four inch square sawn. Corner, end, gate, pull and brace posts shall be six inch minimum diameter, naturally round, or $5\frac{1}{2}'' \times 5\frac{1}{2}''$ square sawn. Lengths shall be as shown in Table A in Part (H). Brace rails used on Type CW fence shall be the same minimum size and shape as the line posts and shall be notched, as shown on the Standard Drawing, either before or after treatment, as shall be agreed upon by the supplier and the contractor. When notched after treatment, the cut area shall be treated as specified by the first paragraph of Article 81.13.

Any other timber or lumber used in the construction of the fence and its appurtenances shall conform, reasonably, to the above requirements.

Posts that are to be driven into the ground shall be tapered in about eight to twelve inches to about a one-inch point on the lower end. The upper end shall be tapered for a minimum of four inches to a round top with a minimum diameter of three inches for line posts and five inches for corner, pull, end, brace and gate posts; this taper is not included in the specified post length. Tapering shall be done prior to treatment. The requirement for extra length at the top will be waived, provided the contractor can drive the posts without damaging the upper end, as shall be decided by the engineer.

All posts and timber used in constructing Type CW fence, or CM fence with wood panels, shall be treated, as specified in Section 51, with pentachlorophenol.

(J) Metal Gates. Metal gates shall be plain-top single drive gates of tubular steel frame with wire fabric filler. They shall be designed to fit openings, between gate posts, of the approximate widths called for by the plans. Single drive gates for openings of less than 14 feet shall be provided with one centered steel upright brace; and for openings of 14 feet or more, with two similar upright braces spaced at third-points in the gate width. All gates shall be provided with one diagonal steel brace.

Metal gates used with Type CW or CM fence shall be filled, as completely as practicable, with galvanized wire fabric securely fastened to top, bottom and ends of gate frame. The fabric shall be a standard design compatible with the type of fence being constructed; the wire gage shall be no less than 12½ in any instance. All materials shall be galvanized Class 1 or better.

Metal gates used in conjunction with wire fence shall have a height of not less than 48 inches. The use of gates having greater heights will be permitted provided they do not extend above the top of gate posts.

The weight of gates shall be about as set forth below:

Width of Opening	Approximate Weight
8	48 pounds
10	55 pounds
12	62 pounds
14	72 pounds
16	80 pounds

Heavier gates will be permitted if conforming otherwise.

Each gate shall be furnished complete with necessary hinges and latch and other hardware designed for use with the type of gate and gate post used on the Project.

A "double gate" shall consist of two single drive gates of equal width and conforming to the above requirements for metal gates, supported at their exterior ends by gate posts and provided with a double gate spring latch holder, a top double gate stop and a bottom double gate stop, or their equivalents, at the interior ends of the gates so designed as to permit the gates to be fastened securely in a closed position. The tube for holding the fastening rod of the bottom double gate stop shall be securely imbedded in concrete. The width designation of a double gate, as it appears in the plans, is the approximate width of the opening, between gate posts, which the two single drive gates are to occupy when used jointly.

(K) Vacant.

(L) Deadman or Anchor. Deadmen or anchors will be used at grade depressions, angle points and other places where unusual stresses will be exerted on the fence. A deadman shall weigh at least 150 pounds and shall be buried in the ground with a cover of not less than two feet. It shall be a precast Portland cement concrete block constructed in accordance with the standard drawing, or other object or thing satisfactory to the engineer. A deadman may be cast in place, when approved by the engineer. An anchor may be (a) a steel or iron bar or rod, at least $1\frac{1}{4}$ " diameter by 3 feet long, with provisions on one end so that a brace wire can be securely retained, or (b) a section of galvanized metal line post at least 3 feet long, or (c) a substitute satisfactory to the engineer.

(M) Concrete. Concrete used as footings for fence posts, braces and other similar purposes shall be Class "F", or better, as specified in Section 46.

(N) Miscellaneous. Bolts, nuts, fittings, hinges, and all other metal parts used in the construction of fences and gates shall be galvanized in accordance with the applicable ASTM designation.

81.13 CONSTRUCTION METHODS. Post holes and excavations for footings and anchors shall be excavated on the lines established by the engineer and to the depths and cross-sections shown on the standard drawings. Wooden posts may be driven when so prepared and any damaged posts shall be repaired or rejected. Metal posts which are not set in concrete footings may be driven. All post hole filling and back-filling work shall be in thin layers and each layer shall be solidly tamped and compacted as it is placed. Posts and braces that are cut or trimmed for any valid reason shall be given two coats of paint conforming to the following:—The paint shall be a varnish containing not less than 5% pentachlorophenol by weight. The varnish shall conform to the varnish specified by AASHO M 69. The pentachlorophenol shall conform to Fed. Spec. TTW 570, and shall be mixed with the varnish in the form of a concentrate. The concentrate shall be 40% penta by weight and 60% solvent and shall weigh approximately 9.85 lbs. per gallon. One pint of the concentrate shall be mixed with one gallon of varnish to produce the required product.

Irregularities in the ground line upon which the fence is being constructed shall be corrected, as determined and directed by the engineer, by use of a bulldozer or any other equipment that will perform a satisfactory job in the engineer's estimation.

All trees, shrubs, brush, rocks and other obstacles which interfere with proper construction of the fence shall be removed by the contractor and the materials so removed shall be disposed of in a manner satisfactory to the engineer.

A "run" of fence between pull posts shall not exceed 660 feet for woven wire nor 990 feet for barbed wire. Changes in alignment of more than 30 degrees shall be considered to be

corners and a double panel shall be installed under such a condition.

Fences crossing drainage courses shall be aligned as shown on the standard drawing. Fence panels shall be set at the locations designated by the engineer. Post spacing shall be, normally, 16.5 feet, excepting panels. When the line of fence is primarily supported by wooden posts, a galvanized metal line post, in lieu of a wooden post, shall be installed each 500 foot run of fence, or one such post in a run of lesser length between end or gate posts, to serve as lightning protection. Holes in which concrete is to be placed shall be thoroughly wet when concrete is placed. When posts and braces are set in concrete the concrete must be fully set before fence wire is stretched in place or gates attached. Posts to be set in rock shall be placed in accordance with directions or approval of the engineer. After the posts, braces and footings have been firmly set and established, the woven wire and barbed wire shall be placed, tightly stretched and fastened to the posts.

Stretching by a motor vehicle will not be permitted; the power must be by or through a mechanical stretcher or device designed for such use. Stretching too tight is more detrimental than too loose.

Fence wire shall be wrapped around terminal posts and fastened to itself. Fence wire, in general, shall be placed on the side of the post opposite the Highway but on curves shall be placed so the force is against the post. The spacing of woven wire and barbed wire shall be as indicated on the applicable standard drawings. Wire stays shall be used on all Type CM and CW fence. The fence shall be so constructed that (1) in the case of a barbed wire fence the bottom wire shall be no closer than 13 inches nor more than 18 inches from the ground; (2) woven wire shall not be on the ground nor more than four inches from natural or graded ground. At grade depressions and alignment angles where stresses tending to pull posts from the ground are created, the wire fence shall be snubbed or guyed at the critical points by brace wire attached to each horizontal line of fence wire and the end of the combined strands being firmly attached to a "deadman" buried not less than two feet in the ground, or to an approved "anchor", at a point which will serve best to resist the pull of the wire fence. "Deadmen" also may be fastened to posts. When and where to use "deadmen" shall be decided or approved by the engineer.

Additional fence wire may be used in some cases to fill depressions. Wire stapled to posts shall be free to move longitudinally. Staples shall be placed angling to the grain of the wood.

Gates shall be installed at the location called for by the plans, in an acceptable manner.

A cross-fence, not the property of the State, shall not be fastened to the State's fence but shall be terminated, in a workmanlike manner, adjacent thereto, but not farther than one foot.

Upon completion, the fence shall be true to line and grade, all posts shall be vertical and firm, and all wire shall be taut and the completed fence shall be completely acceptable in all respects; gates shall open freely and properly; no openings shall be left that will permit stock or animals to pass through the fence.

81.14 METHODS OF MEASUREMENT. (A) Measurement of wire fence shall be the number of lineal rods of completed fence, measured horizontally from outside to outside of gate or end posts, exclusive of gates. If it is necessary, in crossing depressions, to install a double section of fence, vertically, this extra section shall be measured for payment.

(B) Gates shall be measured for length as the horizontal distance between the inside faces of the two gate posts.

(C) Wooden panels on Type CW fence, either 'single' consisting of 2 posts and a rail, or 'double' consisting of 3 posts and 2 rails, and incidentals, but not including the fence wire, shall be considered a unit and bid as such.

Metal panels on Type CM fence, either 'single' consisting of 1 post and 1 brace, or 'double' consisting of 1 post and 2 braces, and incidentals and concrete footings, but not including the fence wire, shall be considered a unit and bid as such. The term "single fence panel—CW." or "double fence panel—CW." in the proposal form shall be interpreted to mean the types shown on the standard drawing and shall be made up of wood members. The term "single fence panel—CM." or "double fence panel—CM." shall be interpreted to mean the types shown on the standard drawing and shall be made of steel posts.

(D) Deadmen will be measured by the number installed and accepted. The quantity shown in the proposal form is an arbitrary quantity for providing a unit price and is subject to substantial increases or decreases, even to none at all. No additional compensation will be allowed because of increase or decrease of bid quantity. When there is no item in the proposal form for deadmen or anchors, such shall be installed when and where required by the engineer, and the costs thereof shall be borne entirely by the contractor.

(E) **Use of Dozer.** Dozer time shall be measured by the hour. Equipment and operation shall conform to Subsection 16.00. Dozer time is to be used in preparing the fence line for building the fence. Any other equipment that will produce equitable results will be permitted and paid for as dozer time.

81.15 BASIS OF PAYMENT. (A) Combination wire mesh and barbed wire fence shall be paid for on a lineal rod basis, measured as specified above.

(B) Gates shall be paid for by the lineal foot measured as provided in Article 81.14 (B).

(C) Fence panels, as defined above, shall be paid for on a unit basis commensurate with the bid item.

(D) Deadmen will be paid for at the price bid for each dead-man accepted in place.

Payment for the various items specified above shall be full compensation for furnishing all labor, materials, tools, and equipment necessary or incidental to the construction of the complete fence and gates, including excavation, backfilling, anchors, tamping, concrete footings, miscellaneous hardware, smoothing the irregularities of the ground at the fence site, clearing the line for the fence or cattle guards, and disposing of all debris—all to the satisfaction of the engineer.

(E) Use of Dozer. Use of dozer shall be paid for by the hour in conformity with Subsection 16.00.

81.16 TYPES AND ABBREVIATIONS. Wire fence and appurtenances shall be placed in several types for administrative and reference purposes. The types shall be as follows:

Single Fence Panel: CW—2 posts and 1 brace rail.

Double Fence Panel: CW—3 posts and 2 brace rails.

Single Fence Panel: CM—

 1 metal post and 1 metal brace, including concrete.

Double Fence Panel: CM—

 1 metal post and 2 metal braces, including concrete.

Type CW Wire Fence—

 3 barbed wires and 32" woven wire on wooden posts.

Type CM Wire Fence—

 3 barbed wires and 32" woven wire on metal posts.

Type CB4M Wire Fence—

 4 barbed wires on metal posts.

Type CB4W Wire Fence—

 4 barbed wires on wooden posts.

Type CB5M Wire Fence—

 5 barbed wires on metal posts.

Type CB5W Wire Fence—

 5 barbed wires on wooden posts.

When wire fence bearing item numbers 8102-8109 (Type F--) is specified, the materials shall conform to Article 79.01.

SECTION 82

CATTLE GUARDS

82.00 DESCRIPTION. "Cattle Guards" shall consist of structures placed in a line of fence, across approaches and roads leading to the roadway, to prevent the straying of livestock onto the Highway, but not obstructing the free passage of vehicular traffic. Cattle guards shall be furnished and installed at the locations shown on the plans, or as directed by the engineer, in accordance with the specifications. Each cattle guard shall be equipped with two wings unless specified otherwise. Applicable standard drawings bear the number prefix 82.

82.01 MATERIALS. **(A) Concrete.** The concrete for the base of the cattle guard shall be Class "A" conforming to Section 46. An air-entraining agent shall be added in conformity with the pertinent provisions of that section.

(B) Structural Steel. All structural steel shall meet the requirements of Section 48, except that crossbars shall be low-alloy weldable steel conforming to ASTM A 242. All other steel shall be structural carbon steel conforming to ASTM A 373.

(C) Reinforcing Steel. All reinforcing bars shall be of intermediate grade billet steel. Deformations shall conform to ASTM A 305 except as otherwise approved. Bends in reinforcing bars shall be made to a radius not less than four diameters of the bar except for stirrups and tie bars which shall be bent around a pin having a diameter of not less than two bar diameters. Hooks shall conform to dimensions shown on the standard drawings.

(D) Wings. Wings connecting the cattle guard to the fence shall be as specified on the standard drawing.

(E) Paint. All metal parts shall receive one shop coat of red lead or zinc chromate conforming to Article 54.04(B)(6) or (7), or as otherwise approved by the engineer.

(F) General. A standard manufactured cattle guard of equivalent strength, with suitable clean-out provisions, may be used if approved by the engineer. All details must be submitted to and approved by the engineer prior to fabrication and before footing elevations are set. All designs must provide for Standard H-20 loading.

82.02 CONSTRUCTION METHODS. **(A)** The concrete base shall be constructed to the lines and grades provided by the engineer and in conformity with the standard drawing. Forms used in constructing the base and methods of mixing the concrete shall conform to the pertinent provisions of Article 46.05 and the standard drawing. Finishing of the concrete shall be

in accordance with Article 46.05(M), except that stringer bearing surfaces must be finished to allow full bearing under each stringer. Any uneven surfaces will be bush-hammered, as directed by the engineer, until the cattle guard rests on the concrete without rocking or warp.

(B) **Cattle Guard.** The metal structure shall be placed upon the concrete base indicated by the standard drawing or as directed by the engineer, and securely fastened thereto.

(C) **Wings.** The metal wings shall be affixed to the cattle guard and connected to the fence as indicated by the standard drawing.

(D) **Painting.** All metal parts shall receive two field coats of paint consisting of first field coat and one coat of aluminum paint in accordance with Article 54.04(B).

(E) **Backfill.** Backfill around the completed structure shall be as directed by the engineer. Clean-up shall be included in requirements.

82.03 METHODS OF MEASUREMENT. Cattle guards shall be measured as a complete unit, as indicated in the proposal. The concrete base shall be considered to be a part of the unit.

82.04 BASIS OF PAYMENT. The lump sum bid price for the cattle guard, complete in place, shall be full compensation for The Work, ready for use.

SECTION 83

SNOW FENCE

83.01 DESCRIPTION. "Snow Fence" shall consist of the furnishing and erection of the specified type of snow fence in accordance with plans and specifications and as directed.

83.02 MATERIALS. (A) **Wood Slats.** Wood slats shall be made from Douglas Fir, Ponderosa Pine, Northern White Cedar, Western Red Cedar, Larch, or wood of equal strength. Slats made from Basswood, Poplar, Cottonwood, Lodgepole Pine or Spruce will not be permitted. The slats shall be a finished dimension of $\frac{1}{2}$ " by $1\frac{1}{2}$ " with a length between $47\frac{1}{2}$ and $48\frac{1}{2}$ inches. The slats shall be well seasoned before weaving, free from wane, cross-grain, splices, knots larger than $\frac{1}{2}$ " diameter and other weakening defects. The ends shall be cut square. Slats shall receive a 5% pentachlorophenol treatment.

(B) **Wire.** The wire shall be Gage $12\frac{1}{2}$, or larger, conforming to ASTM A 121, Class 1, galvanized.

(C) **Steel Posts.** Steel posts used for single deck snow fence shall conform to Commercial Standard 184. The posts

shall be seven feet in length and weigh at least 1.33 pounds per foot. The section may be tubular, T, L, H or U. Posts shall be galvanized in accordance with ASTM A 123. Anchor plate not required.

(D) Wood Posts. Wood posts used for double deck shall be round treated wooden posts of Douglas Fir, Ponderosa Pine, Northern White Cedar, Western Red Cedar, Larch, or Lodgepole Pine. Posts shall be 14 ft. in length with minimum top of 8 inches. Posts shall be straight, sound, and free from defects of all kinds, and shall be cut from live trees not less than 30 days, nor more than one year, in advance of use. All bark shall be peeled and the posts trimmed smooth of all knots or projections. Posts shall receive a pentachlorophenol treatment in accordance with Section 51, 8 lbs. empty cell retention of preservative.

(E) Miscellaneous. Guy wire, board stiffener and other miscellaneous materials shall conform to Standard Drawings.

83.03 FABRICATION. The wire shall be woven into cables consisting of two strands. Slats shall be woven together with five cables. The slats shall be spaced 2 inches apart. Each wire cable shall have two complete turns in each weave in each space between the slats, and at the outside end of each roll there shall be left 1 foot of untwisted cable (two wires) from which samples may be taken for testing. Fabric is to be tightly woven and wires forced into slats in such a manner as to hold them tightly. Fence shall be stretched after weaving and before being placed in rolls. The fence shall be put up in rolls of from 50 to 100 feet as ordered.

83.04 CONSTRUCTION METHODS. Wood slat fence shall be erected in conformance with the plans. The metal posts shall be driven into the ground to the depth required. Wooden poles shall be placed in dug or bored holes and the backfill shall be thoroughly tamped. The wood slat fence shall be tightly stretched and securely wired to the posts. End posts shall be guyed in three directions and intermediate posts shall be guyed as indicated on the plans or as directed. See Standard Drawings. The finished product shall be satisfactory to the engineer.

83.05 METHOD OF MEASUREMENT. Wood slat snow fence will be measured by the lineal foot from outside to outside of end posts, of the completed and accepted work.

83.06 BASIS OF PAYMENT. Wood slat snow fence will be paid for at the contract unit bid price for all fence completed and accepted in place, which price and payment shall be full compensation for furnishing the fence and posts, all materials, including wire, 1" x 4" wood stiffeners, when specified, and all incidentals necessary to complete The Work.

SECTION 86

CONDUITS, DUCTS AND PULL-BOXES

86.01 DESCRIPTION. This work shall consist of the furnishing and installation of conduit or duct, whether metallic, cement, fibre or other specified type, in accordance with the specifications, plans, standard drawings, special provisions or as directed, including all required fittings, junction boxes, pull-boxes, accessories and incidentals necessary to place the item in readiness for installation of cables or wiring.

86.02 MATERIALS. **(A) General.** All electrical equipment shall conform to the standards of the National Electrical Manufacturers (N.E.M.A.) or the Radio Manufacturers Association, whichever is applicable. In addition to the requirements of these specifications, the plans and the special provisions, all material and work shall conform to the requirements of the National Electrical Code, hereinafter referred to as the Code; the Standards of the American Society for Testing Materials (A.S.T.M.); the American Standards Association (A.S.A.); and any state laws or local ordinance which may apply.

Wherever reference is made to the Code, or the standards mentioned above, the reference shall be construed to mean current provisions of the code, order, or standard.

(B) Bituminous Fibre Duct. This material, including fittings, shall conform to Federal Specification W-C-581 and shall be one of the following, as specified:

- (1) Type 1 for encasement in concrete
- (2) Type 2 for burial in earth

Size shall be 3 inch inside diameter unless specified otherwise. One coupling shall be furnished for each joint.

(C) Asbestos Cement Duct. This material, including fittings, shall conform to Federal Specification W-C-571 and shall be one of the following, as specified:

- (1) Type 1 for encasement in concrete
- (2) Type 2 for direct burial in earth.

Size shall be 3 inch inside diameter unless specified otherwise. One coupling shall be furnished for each joint.

(D) Steel Conduit. Rigid steel conduit and fittings shall conform to Federal Specification WW-C-581. Size shall be as shown on the plans. Thin-wall or flexible conduit, and fittings, shall conform to Federal Specification WW-T-806. The interior of all conduits shall have a continuous coating of lacquer ena-

mel. Each length shall bear the label of Underwriters Laboratories, Inc.

(E) Miscellaneous Hardware. Junction boxes and condulets shall be of the size and detail shown on the plans. Anchor bolts shall conform to ASTM A 307, Grade A, and shall be provided with two nuts and two washers each. Drain pipe for junction boxes, shall be as shown on plans. Pull wire shall be No. 12 A.W.G.

(F) Galvanizing. Nuts, washers, junction boxes, anchor bolts, water pipe, pull wires and other ferrous parts shall be galvanized after fabrication in accordance with ASTM A 153 or other applicable ASTM galvanizing specifications; anchor bolts may, as an alternate, be cadmium plated with Type NS coating conforming to ASTM A 165. Construction of bolts and nuts shall be such that nuts will go on to bolts without damage to the coating. Exterior and interior surfaces of all conduit and fittings shall be uniformly and adequately galvanized by the hot-dipped method. The interior and exterior surfaces of the six-inch sample, cut from the center portion of a standard length of conduit, when tested in accordance with ASTM A 239, shall not show a fixed deposit of copper after four one-minute immersions in the standard copper sulphate solution.

(G) Bonding Straps. Bonding straps on structures shall be flexible copper of the same cross-sectional area as No. 4 A.W.G. Strap clamps shall be bronze and shall be the proper size and type for the strap being used.

(H) Concrete Pull Boxes. Concrete manholes and pull boxes and covers shall be of the design shown on the plans or standard drawings. The concrete shall be Class "DD" in accordance with Section 46. Reinforcing steel shall be in accordance with Section 47.

Pull boxes and extensions shall be reinforced concrete boxes of the sizes and details shown on the plans—Type 1 or Type 2 as specified. Reinforcement shall be $\frac{3}{4}$ inch mesh, No. 20 U. S. gage hardware cloth or bar reinforcement. Where isolating transformers are installed in pull boxes, the Type 2 box shall be used. For signal systems, or combined signal and low voltage lighting systems, reinforced concrete covers shall be inscribed "Traffic Signals" and for lighting systems, reinforced concrete covers shall be inscribed "Street Lighting" ("High Voltage," where applicable). Covers shall be provided with two $\frac{3}{8}$ inch brass holdown bolts with brass washers and nuts. Nuts shall be recessed below surface of cover.

Where pull boxes are to be placed in areas subject to traffic loads, a steel cover of suitable design to withstand such loads shall be used in lieu of the concrete cover.

Pull boxes for structure installations shall conform to the dimensions and locations shown on the plans. Boxes or vaults formed in the concrete shall have metal frames and covers,

with wording inscribed on the covers as shown on the plans. Gasket surfaces shall form a true plane. Gaskets shall be of one piece neoprene, $\frac{1}{8}$ inch thick, and shall cover the contact surface between the frame and cover.

86.03 CONSTRUCTION METHODS. (A) Conduits and Ducts. The size and type of conduits, ducts and fittings shall be as shown on the plans. Rigid conduit shall be installed in conformance with Article 346 and thin-wall conduit in conformance with Article 347 of the National Electric Code.

Conduits smaller than one inch electrical trade size shall not be used, unless otherwise specified, except that grounding conductors at service points may be enclosed in $\frac{1}{2}$ -inch diameter conduit.

Where pull boxes are installed adjacent to standard base, conduit installed between pull boxes and base shall not be less than $1\frac{1}{2}$ inches in diameter, unless shown otherwise on the plans.

It shall be the privilege of the contractor, at his own expense, to use larger size conduit, and where such is used, it shall be for the entire length of the run from outlet to outlet. No reducing couplings will be permitted.

The ends of all conduits shall be well reamed to remove burrs and rough edges. Field cuts shall be made square and true so that the ends will butt or come together for the full circumference thereof. Slip joints or running threads will not be permitted for coupling conduit. When a standard coupling cannot be used, an approved threaded union coupling shall be used. The threads on all conduit shall be well painted with a good quality of lead or rust preventive paint before couplings are made up. All couplings shall be screwed up until the ends of the conduits are brought together, so that a good electrical connection will be made throughout the entire length of the conduit run. Where coating on conduit has been injured in handling, or installing, such injured places shall be thoroughly painted with rust preventive paint.

All conduit ends shall be threaded and capped with standard pipe caps until wiring is started. When caps are removed, the threaded ends shall be provided with approved conduit bushings.

Conduit stubs from electrolier base shall extend at least six inches from face of foundation and at least 18 inches below top foundation. Conduit stubs on structures shall be as shown on the plans. Conduit stubs, caps, and exposed threads shall be painted with rust-preventive paint.

The location of ends of all conduits in structures, or terminating at curbs, shall be marked by a "Y" at least three inches high cut into the face of curb, gutter, or wall, directly above the conduit.

Conduit bends, except factory bends, shall have a radius of not less than six times the inside diameter of the conduit. Where factory bends are not used, conduit shall be bent, without crimping or flattening, using the longest radius practicable.

Conduit ends, anchor bolts and other fittings which are to be set in concrete shall be placed and securely held in proper position until the concrete sets.

Conduit and duct shall be laid to a depth of not less than 18 inches below curb grade in sidewalk areas and to a depth of not less than 24 inches below the finished grade in all other areas, except that conduit may be laid on top and secured to the existing pavement in curbed dividing strips. Conduit and duct under railroad tracks shall be not less than 24 inches below bottom of tie.

Conduit shall be placed under existing pavement by approved jacking or drilling methods. Paving shall not be disturbed without the approval of the engineer and then only in the event obstructions are encountered. Upon approval of the engineer, small test holes may be cut in the pavement to locate obstructions. Jacking or drilling pits shall be kept two feet clear of the edge of any type of pavement wherever possible. Excessive use of water such that pavement might be undermined, or subgrade softened, will not be permitted.

Conduit terminating in standards or pedestals shall extend approximately two inches above the foundation vertically and shall be sloped towards handhold opening. Conduit entering concrete pull boxes shall terminate two inches inside the box wall and not less than two inches above the bottom, and shall be sloped to facilitate pulling of cable. Conduit entering through the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduit shall enter from the direction of the run.

Conduit entering controller cabinets shall be sealed to prevent the entrance of gasses, by the use of paraffin or other approved sealing compound, as determined by the engineer. Conduit leading to soffit, wall or other lights or fixtures below the grade of the pull box shall be sealed by means of an approved sealing compound, to prevent water from flowing to the fixture.

A pull wire shall be installed in all conduits and ducts, having a run greater than 10 feet, which are to receive future conductors. At least two feet of pull wire shall be doubled back into the conduit at each termination for runs over 100 feet; one foot will suffice for shorter runs.

Junction boxes and condulets shall be installed in the locations shown on the plans and in such manner that the covers, when in place, will be flush with concrete facing or as may be directed otherwise. Installation shall be according to the Code and shall form a mechanically and electrically secure continuous system.

Conduit expansion joints, as detailed on the plans, shall be installed where the conduit crosses a fixed or an expansion joint in a structure. Each expansion fitting shall be jumpered with a grounding strap. Contact areas shall be thoroughly cleaned before grounding straps are clamped in place.

Bonding of conduit, lighting bracket anchor bolts and bridge rail anchor bolts, as indicated on the plans, shall be made mechanically and electrically secure to form a continuous system.

Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel and blown out with compressed air.

Conduit runs shown on the plans are for bidding purposes only and may be changed, with approval of the engineer, to avoid underground obstruction.

Unless specified otherwise, all ducts shall be not less than three inches inside diameter. All duct lines shall be laid so as to grade down toward manholes, pull boxes or other termination. The minimum grade shall be three inches per hundred feet. Long lines can be high in the center and drain both directions, if necessary. Pockets or traps which would permit accumulation of moisture will not be permitted. The joints of fibre duct and asbestos cement duct shall be painted with an alphaltic base paint to assure a water-tight joint.

Each duct shall be mandrelled after installation. An iron-shod mandrel, not more than one-quarter inch smaller than the bore of the duct shall be used. The mandrel shall be equipped with a leather or rubber gasket slightly larger than the duct hole. The mandrel must be pushed or pulled entirely through the duct line. Sufficient length of pull wire shall be left in pull boxes and manholes to bend the drag wire back to prevent its slipping back into the duct. Where spare ducts are installed the open ends shall be plugged with readily removable tapered plugs designed by the duct manufacturer or with a satisfactory substitute. All ducts shall be securely fastened in place during construction of manholes and pull boxes and plugged to prevent seepage of grout, water or dirt into them. Defective joints shall not be installed. Trenches for ducts shall be excavated manually or with mechanical trenchers. Walls shall be essentially vertical. The trench shall not be more than six inches wider than the outside lines of the duct or ducts. When two or more ducts are installed in a trench, they shall be spaced not less than two inches apart horizontally nor less than six inches apart vertically. The bottom of the trench shall conform to established grade lines and shall be uniformly graded to provide a uniform bearing surface. The duct shall be laid in a layer, at least three inches thick, of dry, fine earth material such as dirt or sand, all of which will pass a quarter inch screen. It shall then be covered with at least three inches of the same type material and firmly tamped in place. When metal conduit is used underground as duct it need not be as carefully covered as duct but other provisions shall apply.

When duct is to be encased in concrete, materials shall be as shown on the plans or standard drawings.

Existing surfaces, disturbed by duct or conduit installations shall be restored to original type and condition when directed.

(B) Pull Boxes and Manholes. Pull boxes and manholes shall be constructed and installed where shown by the plans or as directed. The contractor may, at his own expense, install such additional boxes that he may deem necessary to facilitate the work. Pull boxes and manholes shall be so installed that the covers will be level with curb, sidewalk or surrounding ground. The bottom of the box shall be bedded in concrete or crushed rock in accordance with the plans or as directed.

86.04 METHOD OF MEASUREMENT. **(A)** When a conduit or duct system is bid on a lump sum basis, measurement will be made as a complete system, ready for use.

(B) When conduit or duct is bid by the lineal foot, measurement will be made from end to end of each run of conduit or duct, to the nearest foot.

(C) Manholes and pull boxes will be measured on the unit basis as bid.

86.05 BASIS OF PAYMENT. **(A)** When a conduit or duct system is bid on a lump sum basis, payment will be made for a complete system.

(B) When conduit or duct is bid by the lineal foot, payment will be made for the total number of measured lineal feet of the item.

(C) Payment for manholes and pull boxes will be on the unit basis, including materials, labor, excavation, backfill, crushed rock, extension, and repair of any broken surfaces.

(D) Payment for any and all work and materials bid under this section shall include everything necessary to complete The Work in accordance with the plans and specifications or as directed.

SECTION 87

HIGHWAY ILLUMINATION AND TRAFFIC SIGNALS

87.01 DESCRIPTION. The Work shall consist of furnishing and installing all necessary materials and equipment to complete the installation of traffic signals, lighting, and other electrical systems including modifying existing systems, all as shown on plans or standard drawings and as specified.

87.02 GENERAL. Upon request of the contractor, the engineer will arrange with the serving utility to complete service connections and the contractor shall pay all incurred costs and fees; also, the engineer will arrange for furnishing electrical energy. Energy used prior to completion of the contract will be charged to the contractor, except that the cost of energy used for public benefit, when such operation is ordered by the engineer, will be borne by the State. Unless indicated otherwise on the plans, or specified, all materials shall be new. Where existing systems are to be modified, the existing material shall be incorporated in the revised system, salvaged, or abandoned as specified in the Special Provisions, or as ordered by the engineer. Foundation excavations are to be made and back-filled; concrete foundations are to be constructed; and all improvements and equipment disturbed, damaged, or removed in performing The Work, are to be replaced or repaired. The location of signals, controllers, electroliers, illuminated signs, and appurtenances shown on the plans are approximate and the exact location will be established by the engineer in the field. All incidental parts which are not shown on the plans, or specified, and which are necessary to complete the traffic signal, lighting, or other electrical systems, or required for modifying existing systems, shall be furnished and installed as though such parts were shown on the plans or specified. All systems shall be complete and in operation to the satisfaction of the engineer at the time of completion of The Work.

87.03 REGULATIONS AND CODE. Shall conform to the provisions of Article 86.02(A).

87.04 EQUIPMENT LIST AND DRAWINGS. Within 30 days following notification of award of the contract, the contractor shall submit to the engineer, for approval, a list of equipment and material which he proposes to install, which shall include all material which is identified on the plans or in the specifications. The list shall be complete as to name of manufacturer, size and catalog number of unit, and shall be supplemented by such other data as may be required, including detailed scale drawings and wiring diagrams of any non-standard or special equipment and of any proposed deviation from the plans. If

required to do so, the contractor shall submit for approval, sample articles of the material proposed for use. All of the above data shall be submitted in duplicate for review and, when approved, not less than three complete sets shall be submitted to the engineer. The Commission will not be liable for any material purchased, labor performed, or delay to The Work prior to such approval. All material shall be subject to inspection after delivery to the site and during installation on the project. Failure of the engineer to note defective material or faulty workmanship during construction shall not relieve the contractor of the responsibility for removing or replacing any such material or redoing work at his own expense. Inspection or sampling of certain materials may be made at the factory or warehouse prior to delivery to the site, when required by the engineer. Material which has been rejected previous to delivery shall not be delivered to the project, and all material which has been rejected at the project shall be removed from the site.

Prior to acceptance of The Work, the contractor shall submit two copies of an "As Built" or corrected plan, or any data required by the engineer, showing in detail all construction changes, especially location and depth of conduit and completed schematic circuit diagrams.

87.05 MATERIALS. **(A) Standards and Posts.** Standards and posts for traffic signals, electroliers, cabinets, illuminated signs, etc., shall be as specified or shown on the plans and shall conform to the applicable provisions of Section 42 of the specifications and to the following requirements.

(1) Type I Standards. Type I standards shall be used for post-top mounting of traffic signals as shown on the plans. Mounting height shall not be less than 10 feet, except for special conditions. Type I standards shall be constructed of steel, Gage 11 or heavier, with the top designed for post-top slipfitter.

(2) Type II, III, and X Standards. Type II standards shall be used for mast-arm mounting of traffic signals without luminaires and with or without bracket-mounted traffic signals. Type III standards shall be used for mast-arm mounting of both luminaires and mast-arm traffic signals and with or without bracket-mounted traffic signals. Type X standards shall be used for mast-arm mounting of luminaires with or without bracket-mounted traffic signals. Unless otherwise specified, Types II, III, and X standards shall conform to the details shown on the plans and the following specifications: Standards shall be fabricated from (a) sheet steel conforming to ASTM A 245, Grade C, or from (b) sheet steel of weldable grade. If alternate (b) is used, the steel, after fabrication, shall have a minimum yield of 40,000 pounds per square inch. Standards with one mast arm shall be fabricated of not less than Gage 10 steel except that when material conforming to (b) above is used, the gage shall not be less than 11. Type III standards, with both signal and luminaire mast arms, shall be fabricated of not less than Gage 7 material. Standards shall be fabricated

from full length sheets or from sections not less than 10 feet in length (except the five-foot section added for the 35-foot standards). Each section shall be fabricated from not more than two pieces of sheet steel. Where two pieces are used, the longitudinal welded seams shall be directly opposite one another. When the sections are butt welded together, the welded seams on adjacent sections shall be placed to form continuous straight seams from base to top of standard. Standards shall be straight, with a permissive variation not to exceed one inch measured at the midpoint of a 30-foot or 35-foot standard and not to exceed $\frac{3}{4}$ inch measured at the midpoint of a 20-foot standard.

A maximum static deflection of four inches, without wind load, will be permitted for poles not over 30 feet in height, and $4\frac{1}{2}$ inches for poles 35 feet in height. Static deflection shall be measured with the mast arms, luminaires or signals or both in place. Mast arms shall be fabricated from standard pipe, well reamed, free from burrs, and without intermediate splices or couplings, curved to the dimensions shown on the plans, and shall be provided with rain-tight connections to shafts. Tie rods for mast arms shall be manufactured of structural steel conforming to ASTM A 7 and shall be provided with two nuts and two lock washers at each end. Workmanship and finish shall be equal to the best general practice of modern metal fabrication shops.

The 35-foot standard (unless fabricated from full length sheets) shall consist of the 30-foot standard shown on the plans, with an additional five-foot tapered section, $3/16$ inch thick (8 inches O.D. to $8\frac{11}{16}$ inches O.D.) butt welded to the lower end of the 30-foot standard. The butt welded, transverse joints shall be straightened by inserting a Gage 10 metal sleeve, at each joint, having the same chemical composition as the steel in the standard. The metal sleeve shall have a minimum length of one inch, shall be centered at the joint, have the same taper as the standard, and make full contact throughout its length and circumference. All welds shall be continuous and finished in a smooth, acceptable manner.

All exposed edges of the plates which make up the base assembly shall be finished smooth and all exposed corners of such plates shall be neatly rounded to $\frac{1}{8}$ inch radius unless otherwise shown on the plans. Shafts shall be provided with slipfitter shaft caps.

(3) Standards and posts for Controller Cabinets. Except where noted otherwise, construction shall be of four-inch pipe of the dimensions shown on the plans.

(4) Posts for Pedestrian Push Buttons. When pedestrian push buttons are to be installed on posts in lieu of attaching to adjacent traffic signal standards, the posts shall be constructed of $2\frac{1}{2}$ inch standard pipe of the dimensions shown on the plans.

(5) Standards for Post-Mounted Signs. Standards shall be fabricated of steel pipe with sections swaged and welded as

shown on the plans. Each standard shall be provided with a 3" x 5" handhole with cover plate. Sign frames, for mounting signs on posts, shall be fabricated of standard structural angles welded as shown on the plans. Frames shall be made to present true flat rectangular surfaces for mounting sign panels. All welding shall be done by qualified welders in conformance with the applicable specifications of the American Welding Society. A tolerance of 1/32 inch shall be maintained in the positioning of holes to be used for mounting sign panels.

(6) Bridges for Traffic Signals and Illuminated Signs. Construction shall be as specified or as shown on the plans, or both.

(7) Guard Posts. (a) Concrete. Concrete guard posts shall be constructed of standard pipe, 8 inches in diameter and 5 feet 6 inches long. Pipe shall conform to ASTM A 120, galvanized, Schedule 30, plain ends. Pipe of equal quality will be accepted. Posts shall be set three feet in a block of Portland cement concrete, as shown on the standard drawing and shall be filled with Portland cement concrete, Class "DD".

(b) Wood. Wood guard posts shall be round treated wood posts conforming to Article 90.02 and the standard drawing for round wood guideposts. The minimum diameter shall be 8½ inches; maximum diameter 10 inches; length 5 feet 4 inches. They shall be treated with pentachlorophenol in accordance with Section 51. Wood posts shall be placed in holes and backfill thoroughly tamped to result in a solid structure.

(B) Conduit and Duct. These materials shall conform to Article 86.02. If conduit or duct are not bid as a separate item under a contract for lighting or signals, installation of any required conduit or duct shall conform to Section 86.

(C) Pull Boxes. These materials shall conform to Article 86.02. See standard drawing.

(D) Expansion Fittings. These materials shall conform to Article 86.02.

(E) Miscellaneous Hardware and Galvanizing. All miscellaneous hardware, anchor bolts, nuts, washers, tie rods, etc., shall be galvanized in accordance with ASTM A 153. Standards shall be galvanized in accordance with ASTM A 123.

(F) Conductors and Cable. Conductors and cable shall conform to the applicable specifications as follows:

(1) Traffic Control Conductors and Multiple Circuit Lighting Conductors. Insulation shall be designed for 600 volts. Conductors (unless otherwise specified) shall be single conductor, solid, or stranded copper of gage as shown on the plans, insulated with TW grade plasticized polyvinyl chloride compound. Copper wire shall conform to the applicable portions of ASTM B 3 and ASTM B 8. The insulation shall conform to the applicable portions of ASTM D 734; thickness per Table V,

Column "C". Telephone interconnection conductors shall be No. 16 AWG, 19-strand conductors insulated with 3/64 inch plasticized polyvinyl chloride compound equivalent to TW grade, conforming to the applicable portions of ASTM D 734.

(2) **Multi-conductor Cables.** These shall be used only when specified or approved by the engineer.

(3) **Series Lighting Conductor.** Conductors for series lighting shall be No. 8 AWG, solid or stranded copper, insulated with 10/64 inch TW grade plasticized polyvinyl chloride compound, or equal, conforming to applicable portions of ASTM D 734, and designed for operation at 5,000 volts. Series lighting conductors shall be tested in conformance with the Insulated Power Cable Engineer's Association "General Specifications for Wire and Cable With Rubber and Rubber-like Insulation", February, 1951; Section 7.7—Specifications for "Series Lighting Wire and Cable With Thermoplastic Synthetic Insulation, 3,000 and 5,000 Volt Service". Where isolating transformers are used, the secondary conductor from transformer to luminaire shall be No. 10 AWG, or larger, conforming to specifications for 600 volts.

(4) **Conductor Color Code.** For traffic signal and multiple circuit street lights and signs, insulation shall be of solid color, or of basic colors with a permanent colored stripe, to identify conductors as detailed in Table A, unless otherwise specified.

(G) **Service Equipment.** Service fittings for multiple lighting or traffic signal systems or both shall include a two-wire or three-wire solid neutral, 120- or 120-240 volt, service circuit breaker or service switch, in a raintight housing together with a safety socket box or meter socket or both, located as specified by the power serving utility and as specified or shown on the drawings. Each service switch or service circuit breaker shall be provided with hasp for a padlock to be furnished by others.

For series lighting service, a galvanized cast iron or Gage 16 sheet steel cutout box not less than 13" x 24" x 16" fitted with one plug cut-out for each series circuit shall be furnished and installed. Plug cut-out shall be rated 20 amperes continuous for 5,000-volt circuit and shall short circuit the feed side of the series circuit prior to opening the load contacts. The cut-out shall be operable by removing the cover by means of a hook stick.

Minimum flash-over values of cut-out shall be as follows:	
Contacts to ground	40,000 volts
Load to line contacts, plug removed	32,000 volts
Contact to hand groove in plug	30,000 volts
Across plug separators, with plug inserted	10,000 volts

The cut-out box shall be fitted with a cover permanently inscribed with the words "Danger" and "High Voltage". The cover shall be attached to the box to form a raintight plate and

TABLE A — COLOR AND STRIPE CODE OF WIRING

Code Letter	Circuit	Phase or Function	A.W.G. Number	Conductor Colors	Stripe
S	Lights: Signal	A B C	14 14 14	Red, Yellow, Green Red, Yellow, Green Red, Yellow, Green	Black White None
D	Detectors	D or Special A B C	14 12 12 12	Red, Yellow, Green Blue Blue Blue	Orange Black Black White
P	Pedestrian Buttons	D or Special Common A B C D	14 or larger 14 or larger 14 or larger 14 or larger 14 or larger 14 or larger	Blue Blue Blue Blue Blue Blue	None Orange Black White None None
F	Flashers	—	—	—	Orange
L	Lights: Street Sign	—	—	—	None
X	Service (Any)	—	—	—	None
N	Neutral—All—Circuits— (except detector and pe- destrial b u t t o n com- mons)	—	—	—	None
I	Interconnection	Common	16 (Telephone) 14 or larger (120-Volt)	White White	None None
	Resets	—	16 (Telephone) 14 or larger (120-Volt)	Orange Orange	None None
Y	Spare	—	14 or larger	Black	None

shall require tools for removal. Cut-out box shall be installed not less than eight feet above the ground.

(H) Paint. All paint used shall conform to Section 54, unless specified otherwise, or not covered by that Section. Some colors and types, which are of standard use, fall in the latter category. See Article 87.07 for use and application.

(I) Controllers. **(1) Definition.** A controller shall consist of a complete electrical mechanism for controlling the operations of traffic control signals, including the timing mechanism and all necessary auxiliary equipment, mounted in a cabinet.

(2) Color Phases. Color phases for both traffic-actuated and pre-timed traffic signal systems shall be as set forth below:

(a) For a two-phase controller, the color sequences shall be:

Interval	Phase A	Phase B
1	Green	Red
2	Yellow	Red
3	Red	Green
4	Red	Yellow

and repeat

(b) For a three-phase controller, the color sequence shall be:

Interval	Phase A	Phase B	Phase C
1	Green	Red	Red
2	Yellow	Red	Red
3	Red	Green	Red
4	Red	Yellow	Red
5	Red	Red	Green
6	Red	Red	Yellow

and repeat

(3) Flashing Operations. All controllers shall be equipped for flashing operation of signal lights. Flashing operations, when required by railroad preemption, flashing control, or other causes, shall be set for flashing yellow lights on the main street or highway and for flashing red on the cross street or streets, unless otherwise specified, or directed by the engineer.

(4) Railroad Pre-emption Equipment. Such equipment shall be constructed and wired to isolate the controller and

assume control of signals. Pre-emption shall cause a "yellow" indication to be displayed prior to "flashing red" indication if actuated during "green" or "flashing yellow" interval, unless otherwise specified. Railroad pre-emption equipment shall be installed so that internal wiring of the controller, as normally furnished by the manufacturer, is not altered.

(5) Wiring Diagrams. A schematic wiring diagram of the controllers and auxiliary equipment shall be submitted at the time the controllers are delivered or, if ordered by the engineer, previous to purchase. This diagram shall show, in detail, all circuits and parts. Such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted. See Article 87.04.

(6) Operating Voltage. All equipment, excepting pedestrian push button and pressure detectors, shall be designed to operate from 120 volt, 60 cycle, AC supply. Operation shall be satisfactory at voltages from 110 to 130. The voltage for pedestrian push buttons and pressure detectors shall not exceed 12 volts.

(7) Radio Interference Suppressors. All traffic signal controllers, flashers or other current interrupting devices, shall be equipped with suitable radio interference suppressors installed at the input power point. Interference suppressors shall be of a design which will minimize interference in both broadcast and aircraft frequencies, and shall provide a minimum attenuation of 50 decibels over a frequency range of 200 kilocycles to 75 megacycles when used in connection with normal installations. The interference filters shall be hermetically sealed in a substantial metal case filled with a suitable insulating compound. Terminals shall be nickel plated, 10-24 brass studs of sufficient external length to provide space to connect two No. 8 wires, and shall be so mounted that they cannot be turned in the case. Ungrounded terminals shall be properly insulated from each other, and shall maintain a surface leakage distance of not less than $\frac{1}{4}$ inch, between any exposed current conductor and any other metallic parts, with an insulation factor of 100-200 megohms dependent on external circuit conditions. Suppressors shall be designed for operation on 15 amperes, 125 volts, 60 cycles, single wire circuits, and shall meet standards of the Underwriters' Laboratories and the Radio Manufacturers Association.

(8) Traffic-Actuated Controllers. These shall be electrical devices which, when connected to traffic detectors or other means of actuation, or both, shall operate the electrical traffic signal system at one or more intersections.

(a) Type I Controller. This shall be a two-phase, full traffic-actuated control device which shall be capable of transferring traffic control indication from one phase to the other as the movement of traffic demands. Each phase shall be separately controlled for a predetermined initial interval; predetermined vehicle interval, extended for each actuation; predeter-

mined maximum interval, which is the limit one phase can hold the right-of-way while there are actuations on the other phase; predetermined yellow interval; and a recall switch.

Each phase shall be separately controlled by dials (installed on the front panel of the controller) readily adjustable for the following variables:

- (1) Initial interval from 2 to 30 seconds.
- (2) Vehicle interval from 2 to 30 seconds.
- (3) Maximum interval from 10 to 60 seconds.
- (4) Yellow interval from 1 to 10 seconds.

Provision shall be made so that, if a vehicle actuates that controller during the green or yellow interval of a phase and does not receive a full vehicle interval, the green shall be recalled to that phase upon completion of the other phase.

(b) Type II Controller. This shall be a three-phase, full traffic control device with similar functions as the Type I controller except that three phases shall be provided. The controller shall be provided with mechanism for skipping any phase when there is no call for that particular phase. When the controller is part of an interconnected system, transfer of the right-of-way from the coordinated phase shall occur only during the permissive period.

(c) Type III Controller. This shall be a two-phase, full traffic-actuated traffic control device which shall be capable of transferring control indication from one phase to the other as the movement of traffic demands and shall be capable of increasing and decreasing the various time intervals due to variations in volume of moving traffic and of waiting traffic.

Pilot lights shall be provided to indicate the position of the controller at all times with regard to operating intervals on each traffic phase and also to indicate which of the several effects is responsible for termination of right-of-way.

Each phase, provided with a recall switch, shall be separately controlled by dials (installed on the front panel of the controller) readily adjustable for the following variables:

- (1) Minimum initial interval from 5 to 60 seconds.
- (2) Number of cars before minimum initial interval starts to increase from 5 to 50.
- (3) Increase of initial interval per car from 0.1 to 2 seconds.
- (4) Carry-over effect of traffic during previous green period from 10 to 90 percent.
- (5) Passage time for slow-moving vehicles from 5 to 15 seconds.
- (6) Maximum period from 10 to 90 seconds.
- (7) Change period from 1 to 10 seconds.
- (8) Low limit to which vehicle interval can be reduced by waiting time of other phases from 1 to 10 seconds.

- (9) Low limit to which vehicle interval can be reduced by number of other phase waiting cars, from 1 to 10 seconds.
- (10) Low limit to which vehicle interval can be reduced by own phase density from 1 to 10 seconds.
- (11) Seconds waiting to reduce to low limit from 10 to 90 seconds.
- (12) Number of cars waiting to reduce to low limit from 5 to 50, in intervals.
- (13) Number of cars per 10 seconds to reduce to low limit 5 to 50, in intervals.

(d) Type IV Controller. This shall be a three-phase full traffic-actuated traffic control device with similar functions as the Type III controller, except that three phases shall be provided and the panel dials shall be readily adjustable for the variables, set forth below—1 to 8.

The controller shall be provided with a recall switch for each phase and provisions for skipping any phase when there is no call for that particular phase. Pilot lights shall be provided to indicate the position of the controller at all times with regard to operating intervals on each traffic phase and also to indicate which of the several effects is responsible for termination of right-of-way.

- (1) Minimum initial interval from 5 to 60 seconds.
- (2) Number of cars before initial interval starts to increase from 5 to 50.
- (3) Increase of initial interval per car from 0 to 2 seconds.
- (4) Passage time for slow-moving vehicles with recall provision from 5 to 15 seconds.
- (5) Low limit to which vehicle interval may be reduced by waiting time of other phase from 1 to 10 seconds.
- (6) Seconds of waiting on other phases to reduce vehicle interval to low limit from 10 to 90 seconds.
- (7) Maximum period from 10 to 90 seconds.
- (8) Change period from 1 to 10 seconds.

(e) Type V Controller. This shall be a two-phase, semi-traffic actuated control device which shall, in response to calls from the side street, transfer the right-of-way to the side street. When the controller is part of an interconnected system, transfer of the right-of-way to the side street shall only be during the permissive periods controlled by a circuit connected to a local synchronization unit or local offset unit.

The controller shall be readily adjustable for the following variables:

- (1) Main street minimum green interval from 10 to 90 seconds.
- (2) Main street change interval from 2 to 10 seconds.
- (3) Side street initial interval from 2 to 12 seconds.

- (4) Side street vehicle interval from 2 to 12 seconds.
- (5) Side street maximum interval from 10 to 60 seconds.
- (6) Side street change interval from 2 to 10 seconds.

(f) Mechanism for Traffic-Actuated Controllers. These shall be electrical devices with construction equal to that of first-class electrical instruments. Each variable shall be individually adjustable over its entire range by indicating type knobs, mounted on the timing panel of the controller. Changing the timing of one interval shall not change the timing of any other interval. The controller shall be so designated that temperature variation between minus 30°F. and 130°F. shall not change the timing interval by more than five percent. All similar parts shall be interchangeable. All contact points which make, break or carry electrical current shall be of fine silver or silver alloy and shall be capable of making, breaking and carrying a current of 150 percent of maximum demand load of that particular circuit without causing electrical or mechanical trouble through 1,000,000 operations. All bearings (except approved sealed bearings) or moving parts shall be of such design that lubrication at one-year intervals shall be sufficient to assure continuous operation. The complete controller and each auxiliary equipment as specified shall be assembled, wired, and housed in separate dust-proof metal cases. All circuits of each unit shall terminate in a multiple contact connector. Connections between the connector and the terminal block shall be made by means of a flexible cable. Conductors of the cable shall be fitted with terminals to match the terminal block and shall have identifying tags. In addition to actuation by vehicles, provisions shall be made, in the mechanism for each phase, for proposed or potential actuation by means of pedestrian push buttons, or railroad pre-emption or both, without altering controller mechanism.

(g) Auxiliary Equipment for Traffic-Actuated Controllers. The auxiliary equipment described below shall be furnished and installed in each cabinet for traffic-actuated controllers:

(1) Flasher and Switch-Operated Multi-Contact Relay. Operation shall cut in flasher and isolate controller from light circuits. Flasher shall be a motor driven, or electronic device, producing between 50 and 60 flashes per minute, and shall provide equal on and off intervals. Flasher mechanism shall be furnished mounted on a plug-in base with plug-in mounting. Multi-contact relay or relays shall have sufficient number of contacts to permit any combination of flashing red and yellow lights and shall be similar in construction to external light relay specified for use with traffic-actuated controller.

(2) External Light Relays. External light relays for controllers shall be furnished and installed in controller cabinet, external to the controller, unless provided otherwise in the plans or special provisions.

Relay assembly shall be one of the following types as specified.

Type 1. For two-phase controllers—two double pole, double contact, double throw relays each mounted on a base for plug-in mounting. For three-phase controllers—six single pole, double contact, double throw relays, mounted as above specified.

Type 2. For each separate phase three single pole, single throw relays, mounted on a base for plug-in mounting.

Relays shall be designed for continuous duty and shall be fitted with silver alloy contacts not less than $\frac{3}{8}$ inch in diameter, carried on phosphor-bronze arms. Contacts shall be rated at 120 volts, 20 amperes, 60 cycles. Movable armature shall be of the coil spring return type. Each relay or group of relays shall be furnished mounted on a plug-in base with plug-in mounting. Banana spring type plugs and jacks shall be used for plug-in type mountings.

When the plans or special provisions specify that external light relays will not be required, the signal light mechanism shall meet the requirements of Article 87.05 (I) (9) (c) (2).

(h) Special Auxiliary Equipment. This shall be furnished and installed when shown on the plans or required to perform specified functions, and shall consist of:

(1) Overlap Relays. Relays to provide overlap shown in phase diagrams. Overlap relays shall be the same types as specified above for external light relays.

(2) Timers. Interval timers for special timing.

(3) Pedestrian Interval Timer. Interval timer for pedestrian actuation which shall be a control actuated by pedestrian push buttons and capable of controlling any of the full traffic-actuated or semi-traffic-actuated controllers to provide for pedestrian traffic. Actuation of the pedestrian push buttons shall result in the transfer of right-of-way in the same sequence as would normally occur in vehicular actuation. The period shall be readily adjustable between the limits of 5 seconds and 30 seconds.

(4) Railroad Pre-emption Relays. These shall be of the same types specified for external light relays and shall perform the operations specified in Article 87.05(I)(4). Where flashing indication is required the flasher normally provided with the controller shall be wired into the pre-emption circuit.

(5) Directional Detector Relay. One unit for each phase using directional detectors. Quality of construction of unit shall be equal to that required for controllers.

(6) Telephone Relays. Used for interconnection.

(i) Controller Housing. Each traffic-actuated controller shall be housed in a weather-proof, anodized cast aluminum cabinet, of sufficient size to contain the controller, all auxiliary

equipment, and the fittings listed below, or as shown on the plans.

(1) **Shelves.** Substantial shelves or brackets to support controller and auxiliary equipment.

(2) **Control Panel Assembly.** This shall consist of:

(a) Plug fuse receptacle.

(b) Main power switch.

(c) Controller switch. The controller switch shall be wired to energize the controller timing circuits while the signal lights are off or are being operated by flasher.

(d) Three-wire, 15 ampere, plug receptacle with grounding contact.

(3) **Terminal Blocks.** Two or more insulated terminal blocks for terminating field wires. Each block shall be provided with 12 poles with pressure type connectors to accommodate not less than five wires, size No. 14 AWG.

(4) **Cabinet Door.** The cabinet shall have a main door which shall be equipped with a keyed tumbler lock, and an auxiliary door equipped with lock and police key. Door hinge pins shall be made of stainless steel material. Two keys shall be furnished for each lock. The police key shall have a shaft at least $1\frac{1}{3}$ " long. Cabinet shall be installed with the back toward the nearest line of traffic.

(5) **Panel Behind Auxiliary Door.** This shall contain the following:

(a) Main power switch.

(b) A switch to control the change from automatic to flashing operations and vice versa. In the "flashing" position the controller shall be de-energized.

Switch terminals on rear of main cabinet door shall be insulated so that no live parts are exposed.

(6) **Cabinet Vents.** Screened raintight vents $1\frac{1}{2}$ inches in diameter, or larger, shall be furnished and installed in the top and the lower back side of the controller cabinet. A one-inch drain hole or pipe, with screen, shall be placed in the foundation connecting to the cabinet and emptying above the ground line, where cabinet is mounted on concrete pedestal.

(7) **Cabinet Wiring.** All wiring within cabinet, including connecting cables but excluding wiring within controller timing unit, shall have insulation conforming to Article 87.05(F)(1), except that connecting cables shall be of stranded copper with $2/64$ inch thickness of insulation.

(9) **Pre-Timed Controllers.** These controllers shall be for the purpose of operating pre-timed traffic signal systems and shall be electro-mechanical control devices complete with all accessories and equipment necessary to perform the functions specified below:

(a) **Types and Functions.**

(1) Non-Expandible.

Type XXI: Non-interconnected controller.
Type XXII: Future interconnected controller.
Type XXIII: Interconnected controller.
Type XXIV: Combined master and intersection interconnected controller.

(2) Expandable.

Type XXV: Future interconnected controller.
Type XXVI: Interconnected controller.
Type XXVII: Combined master and intersection interconnected controller.

(b) Operation. All pre-timed controllers shall be capable of operating as follows:

- (1) Manually.**
- (2) As a pre-timed controller of the independent isolated type.**
- (3) As a synchronous motor-driven coordinated type for progressive timing without interconnecting circuits.**

Controllers shall be either one, two, or three dial as specified. Types XXV, XXVI or XXVII controllers shall be the expandable type designed to permit the installation and operation of one to three plug-connected dial units without additional wiring or modification of the controller. Types XXII and XXV controllers shall be capable of being operated as future units in an interconnected, master controlled, flexible progressive system by the addition of easily installed auxiliary attachments. Types XXIII and XXVI controllers shall be capable of being operated as units in an interconnected, master controlled, flexible progressive system and shall have single electro-mechanical reset per dial unless otherwise specified. Types XXIV and XXVII controllers shall be similar to Types XXIII and XXVI controllers, except that they shall be equipped with master reset supervision of the intersection controllers.

(c) Mechanism for Pre-Timed Controllers. This shall be constructed as a complete, self-contained, readily interchangeable unit arranged to swing out for inspection while in operation. All parts shall be readily accessible for maintenance or replacement. All circuits of each unit shall be terminated in a multiple contact connector. Connector and the terminal block shall be connected by a flexible cable. Conductors of the cable shall be fitted with terminals to match the terminal block and shall have identifying tags.

(1) Motor and Dial Controller Motor. Shall be of the self-starting synchronous type, and shall have ample torque for the requirements of the controller operation. No shaft in motor gear train, except armature spindle, shall be less than 0.125" di-

ameter. No gear shall be less than 0.045" thick. No bearing plate shall be less than 0.0625" thick. All intervals in each phase shall be readily adjustable by a suitable dial on the face of the controller in steps of not to exceed 1 per cent of the total cycle by means of self-retained timing keys.

(2) Signal Contact Mechanism. All parts of the contact mechanism for signal lights, including contacts and contact supports, shall operate 1,000,000 times without mechanical wear that impairs normal operation. All signal light contact points shall be of fine silver or silver alloy not less than 5/16" diameter, of not less than 10-ampere capacity, capable of operating 1,000,000 times without excessive burning or pitting, and shall be easily removed and replaced. Cam or drum assembly shall provide not less than 12 intervals, all necessary contacts, and provisions for not less than 15 signal light contacts. Wiring shall be complete to terminal strip from each contact position.

(d) Auxiliary Equipment. All pre-timed controllers shall be equipped with indicating switches and wiring to provide local control of the following functions:

- (1) Transfer from automatic to manual operation and vice versa.
- (2) Transfer from normal operation to flashing and vice versa.
- (3) Transfer from one dial to another (multidial or expandible controllers only).
- (4) Turn off signal lights only (without shutting down timer mechanism).
- (5) Shut down timer mechanism.

Combined master and intersection controllers shall have indicating switches for Functions (2) and (3) above for the interconnected systems. Switch for local control of Function (3) is not required at the master. Combined master and intersection controllers shall also have provisions for time switch control of Functions (2) and (3) above for the interconnected system. Interconnected controllers shall have provisions for remote control of Functions (2) and (3) above. Non-interconnected controllers shall have provisions for local time switch control of Functions (2) and (3) above. All pre-timed controllers shall be wired and furnished with plug-in-mounted flasher and jack-mounted relays to permit any combination of flashing red or yellow lights, or both, and shall conform to Article 87.05(I)(8)(g)(1). All pre-timed controllers shall be provided with hand switch and cord set for manual operation of signals. A readily accessible mounting panel shall be furnished in each pre-timed controller cabinet, with adequate provisions for terminating all field circuits and for mounting fuses and relays. Each power and inter-connect circuit (except neutrals) shall be fused.

(e) Special Auxiliary Equipment. The special equipment listed below shall be furnished and installed when specified or shown on the plans: Time switches to control system or local flash, dial change, or other specified functions. Time switch shall be synchronous motor driven equipped with 10-hour spring wound reserve carry-over, omitting device and three openings and closings per 24-hour period. Mechanical and electrical characteristics shall be equal to those specified for "Mechanism for Pre-time Controllers" above.

(f) Railroad Pre-Emption. Such relays, when required, shall perform the operations specified in Article 87.05(I)(4).

(g) Housing for Pre-Timed Controllers. The controller shall be enclosed in a weatherproof metal cabinet of the type regularly supplied by the manufacturer, unless otherwise specified. Cabinet shall be fitted with a master-keyed, police lock and shall be mounted on a pedestal, as shown on the plans. Two keys, with shanks at least $1\frac{3}{4}$ " long, shall be furnished for each controller. Cabinet shall be fitted with slipfitter attachment to permit posttop mounting on a 4" standard pipe pedestal. Screened raintight vents, $1\frac{1}{2}$ " or larger, shall be furnished and installed on top and the lower backside of the controller cabinet.

(J) Traffic Signals and Appurtenances. **(1) Signal Heads.** Each signal head shall be of the adjustable, colored light, vertical type with the number and type of lights detailed herein, and as shown on the plans; shall provide a light indication in one direction only; shall be adjustable through 360 degrees about a vertical axis; and shall be mounted as and where shown on the plans. Unless otherwise shown on the plans, all signal heads shall be standard and shall contain three lights arranged: red—top; yellow—center; green—bottom. Pedestrian signals shall be either the gas tube type or the incandescent type as specified and shall be installed where shown on the plans. All signal heads at any one intersection shall be of the same make and type.

(a) Optical Units. The optical unit shall consist of a lens, a reflector, a lamp holder, and a 67-watt, 130-volt, clear, group replacement, traffic signal lamp, visible to the traffic to be controlled, at all distances from 10 feet to 500 feet, under all light and traffic conditions except dense fog.

Lenses shall be the color indicated, circular in shape, with a visible diameter of approximately eight inches, and of such design as to give an outward and downward distribution of light with a minimum above the horizontal. Each lens shall be true to color, of best quality glass, free from imperfections, of high illumination transmission, and shall conform to latest specifications of the Institute of Traffic Engineers.

Each reflector shall consist of a one-piece, best quality, clear glass parabolical reflector, free from bubbles and striae. The convex surface shall be silvered by chemical deposition to such

thickness that the lighted filament of a 150-watt incandescent lamp will not be visible through the silver layer. The silvered surface shall be protected by an additional coating of electrolytically deposited copper. An opening in the back of the reflector for the lamp holder shall be so constructed that there will be no dark spots cast on the lens. The lamp holder shall be of weatherproof mounted construction, immune to the operating temperatures of the unit, of the vibration proof type, and shall be substantially supported independent of the reflector. It shall be provided with two wires of sufficient length to be connected to the terminal block specified below, or each reflector, lens and hood shall be designed in such a manner as to reduce sunphantom to a minimum.

(b) **Housing.** The signal head housing, or case, shall consist of an assembly of separate sections, expandible type for vertical mounting, substantially secured together in a watertight manner to form a unit of pleasing appearance. Each section shall house an individual optical unit. Each section shall be complete with a one-piece hinged door, mounting for the lens and the other parts of the optical system, watertight gaskets, and a simple, non-corrodible door-locking device. The optical system shall be so mounted that the various parts may be swung open for ready access or removal. The sections shall be interchangeable and so constructed that sections can be removed or added. There shall be a round opening in the bottom and top of each head to receive a 1½" supporting pipe frame. All parts of the housing, including the doors and end plates, shall be of die cast anodized aluminum conforming to ASTM B 85, and all parts shall be clean, smooth, and free from flaws, cracks, blow holes, or other imperfections. All parts such as hinge pins, lens clips, locking devices, etc., shall be made of non-corrodible material.

A terminal block of an approved type shall be mounted inside at the back of the housing. All sockets shall be so wired that a white wire will be connected to the shell of the socket and a black wire to the bottom, or end terminal, of the socket. These wires shall, in turn, be connected to the terminal block, mounted in the housing, in the proper manner. The terminal block shall have sufficient studs to terminate all field wires and lamp wires independently, to the block, with separate screws. The terminals to which field wires are attached shall be permanently identified to facilitate field work. Where terminal compartment is used, terminal block in associated heads may be omitted.

Each lens shall be protected with a removable hood of 0.030" thick sheet adonized aluminum of the full-circle type completely closed, except at the ends, 8" long (unless otherwise specified) and so designed as to prevent a false indication to traffic not intended to be controlled by that particular signal face. The inside surface of all hoods shall be painted a flat black to prevent reflection.

(2) **Directional Louvers.** Where shown on the plans,

louvers shall be furnished and installed in signal hoods. Directional louvers shall be so constructed as to have a snug fit in the signal hoods. The outside cylinder shall be constructed of Gage 22 sheet steel and the vanes shall be constructed of Gage 27 sheet steel. Dimensions and arrangements of vanes shall be as shown on plans. Louvers shall be galvanized in conformance with ASTM A 153, and painted with two coats of weather resistant flat black enamel.

(3) Back Plates. Where shown on the plans, back plates shall be furnished and attached to the signal heads. Back plates shall be constructed of anodized, 3-S, half-hard, aluminum sheet, 0.058" minimum thickness, and of the dimensions shown on the plans. Back plates shall be painted as specified in Article 87.07.

(4) Mounting Brackets. Bracket mounted signal heads, as shown on the plans, shall be supported by mounting brackets consisting of assemblies of 1½" standard steel pipe and malleable iron or brass pipe fittings. All members shall be either plumb or level, symmetrically arranged, and securely assembled. Construction shall be such that all conductors are concealed within poles and assembly. At each signal location, unless shown otherwise on the plans, a terminal compartment shall be constructed into the mounting brackets, as detailed on the plans. For post-top mounting of bracket-mounted signals the terminal compartment shall be cast with an integral slip-fitter. For post-top mounting of a one-way signal head a slip-fitter without a terminal compartment may be used. Slip-fitter shall fit over a 4" standard pipe. Each slip-fitter shall be provided with two rows of set screws with three screws in each row to secure assembly in plumb position. Set screws shall be cadmium plated. Where signal heads are mounted on electroliers or other tall poles, the compartment shall be designed to bolt or clamp securely to the pole. Each compartment shall be fitted with a terminal block containing 12 poles, each with two pressure type connectors. Each connector shall accommodate at least five No. 14 conductors. A raintight cover shall be provided giving ready access to the terminal block. Terminal compartment shall be of non-frangible metal containing not less than 60 per cent copper and shall be of sufficient strength to remain intact in event the pole is knocked down. Slip-fitters, where used without integral terminal compartment, shall be of cast iron or copper-bearing metal as specified for terminal compartments.

(5) Signal Head Mounting. Signal heads shall be equipped with positive lock rings and fittings designed to prevent heads from turning due to external forces. Lock ring and connecting fittings shall have serrated contacts as shown on the plans. Signal head assembly for suspension from mast arm shall be equipped with an internally wired plumbing device.

(6) Installing Signal Heads. Signal heads shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at

that intersection, except that the signal heads may be mounted if the faces are not directed toward traffic or if the faces are covered.

(7) Detectors. Detectors shall be used for actuating traffic-actuated controllers and shall be pressure sensitive type or magnetic detector type as shown on the plans.

(a) Pressure-Sensitive Vehicle Detectors. These shall be of the non-directional or the directional types or both and of the lengths shown on the plans. Non-directional detectors, in combination with control equipment, shall be capable of actuation by a vehicle crossing the detector at any speed up to 60 m.p.h. under normal conditions. Directional detectors, in combination with control equipment, shall be capable of actuation by a vehicle crossing the detector in one direction at any speed up to 35 m.p.h. under normal conditions, but not when crossing the detector in the opposite direction. A directional detector relay unit shall be furnished and installed in the controller cabinet for each phase having a directional detector. Detectors shall be mounted in a steel frame or housing, having a splicing chamber. The chamber shall be placed in such a position that the chamber door or cap can be opened without disturbing the pavement. All necessary anchoring and installation accessories shall be supplied with each detector. Provision for draining the splice box shall be provided. Pressure type detectors shall be connected by rigid conduit to the nearest junction box. The detector housings shall be so constructed that contact elements of either the directional or non-directional type can be inserted without disturbing the installation in the pavement. Detector pad shall be prepared as specified in Article 87.06.

The contact elements of detectors shall be of one-piece construction and shall be so designed that no metal screws or bolts shall be exposed to traffic wear. The surfaces of detector units, which are exposed to traffic, shall consist of rubber 1" thick. The rubber shall be especially compounded for the duty which it is to perform, and shall be securely vulcanized to metal base plate of the contact element. Bolts which hold the contact elements in the housing shall be well graphited before installation and shall not extend above the pavement surface. The rubber surface exposed to traffic shall not be less than 8" wide and the length shall be approximately the length of the detector. The surface shall not be higher than $\frac{1}{8}$ " above the rim of its housing and in no case shall the surface be lower than $\frac{1}{8}$ " below the rim. The electrical contact area of the contact assembly shall be moisture proof and arrangements shall be provided for making a water proof splice between the contact area and the conductors. Detectors shall be so constructed that they will operate on a normally open electric circuit and will make an electrical contact whenever any motor vehicle wheel passes over the detector. Pavement and base material removed for the installation of the detector housing and foundation, cuts in existing concrete pavement, and concrete foundation for the detector shall be performed in accordance with Article 87.06.

(b) Calling Detectors. These shall be pressure sensitive type as described above. Controller circuits shall be wired so that calling circuit shall not operate if advance detector has been actuated.

(c) Magnetic Detectors. These shall consume no power, and shall contain no moving parts. They shall not be rendered inoperative or continuously operated by parked cars or other fixed iron objects such as road reinforcement, water or gas pipes, etc., which may be within their zone of influence. Extremes of temperature or humidity shall not affect proper operation of magnetic detector equipment. Magnetic detectors shall be moisture-proof and capable of withstanding all soil conditions without impairing their efficiency. All coils shall be waterproofed by the vacuum impregnation process. Magnetic detectors shall have sufficient mechanical strength to withstand the transmitted shock of traffic without damage.

(1) Non-Directional Magnetic Vehicle Detector. The detector, in combination with the magnetic detector relay specified below, shall be capable of providing a road coverage adjustable up to 15 feet from the detector, this coverage being subject to speed limitations approximately as follows, intermediate values being proportional.

- (a) For 15 feet from the detector—Speeds of 12-60 m.p.h.
- (b) For 10 feet from the detector—Speeds of 8-60 m.p.h.
- (c) For 5 feet or less from the detector—Speeds of 4-60 m.p.h.

The magnetic elements of the detector shall be housed in an appropriate non-ferrous case. The detector shall have an internal resistance not to exceed 3,500 ohms and shall be designed for operation with magnetic detector relays of the vacuum tube amplified type. Each detector shall be provided with suitable means for making a closed conduit system and shall include insulated leads at least 15 feet long.

(2) Directional Magnetic Vehicle Detector. Any detector having two magnetic circuits shall be considered to be a compensated detector under the terms of this specification. The magnetic material and coil assemblies shall consist of an integral unit assembly for placing in position in the roadway. Detectors of the compensated type shall be so designed and constructed that they will not be actuated by external magnetic fields caused by currents or current changes in adjacent electrical conductors such as street car tracks or feeders, power cables, etc. The compensated magnetic detector shall have a sharply defined zone of influence, which shall be substantially the same as its over-all length. The compensated magnetic detector shall detect cars which pass through its zone of influence at speeds up to 60 m.p.h. only in a direction towards the intersection. The detector shall be designed to permit balancing of any non-symmetrical magnetic disturbances caused by road-reinforcing, pipes, manholes, etc., in the direct

vicinity of the detector. This design shall be of such nature as to allow adjustment of the discrimination of the detector for vehicles traveling over the detector in the reverse direction against those in the forward direction. The compensated magnetic detector shall have an internal resistance not to exceed 3,500 ohms and shall be designed for operation with magnetic detector relays of the vacuum tube amplifier type. The elements of the detector shall be suitably housed for mechanical protection. Each compensated magnetic detector shall be provided with a suitable means for making a closed conduit system with provisions for a splicing chamber at the road surface.

(d) **Magnetic Vehicle Detector Relays.** These shall be of the vacuum tube amplifier type. The input circuit shall have an impedance greater than 75,000 ohms. Any contact which opens or closes in response to vehicle actuation shall be capable of making, breaking and carrying three amperes at 155-volts, A.C. The sensitivity of the magnetic vehicle detector relay shall be adjustable from the front of the case by means of a knob. Magnetic detector relays shall be designed for operation on a 115-volt, 60 cycle A.C. supply. Maximum power consumption shall not exceed 15 watts. The magnetic detector relay shall be suitably enclosed in a protective and durably finished sheet metal case. The overall dimensions shall not exceed 4" x 10 $\frac{1}{4}$ " x 5" (optional 8" x 6" x 5"). It shall be supplied for plug connection.

(8) **Pedestrian Push Buttons.** Where shown on the plans, pedestrian push buttons of substantial tamper-proof construction shall be furnished and installed. They shall consist of direct push button and a single monetary contact switch in a cast metal housing on which shall be attached the push button sign shown on the plans. The switch shall have snap action contacts actuated by a three-bladed beryllium copper spring and shall be rated 10 amperes, 125 volts.

The assembly shall be weatherproof and so constructed that it will be impossible to receive any electrical shock under any weather condition. The housing shall be shaped to fit the curvature of the pole to which it is attached, to provide a rigid installation. Saddles shall be provided to make a near fit, when required. Push button and sign shall be installed on the cross-walk side of the pole.

(9) **Pedestrian Signals.** Pedestrian signals shall be rectangular in shape and shall contain the lettered messages **WALK** and **DON'T WALK**. The design and construction of the **DON'T WALK** signal shall be such that, in the case of an electrical or mechanical failure of the word **DON'T**, the word **WALK** will also remain dark. All pedestrian signals within one intersection shall be of the same approved type. Relays for the operation of **DON'T WALK-WALK** signals shall be placed in the controller cabinet.

(a) **Type 1—Gas-Filled Formed Tubing.** The letters shall be at least 4 $\frac{1}{2}$ " high and shall be in two lines. The **WALK** in-

dication shall be green, and the **DON'T WALK** indication shall be red. Housing shall be a one piece aluminum alloy casting. Transformers, wiring, and terminal blocks for field connections shall be located in the rear compartment. Both front and rear compartments shall be dustproof.

(b) **Type 2—Incandescent.** The letters shall be at least 3 inches high. The **WALK** and **DON'T WALK** signals shall be in separate signal sections. The **WALK** lens shall be lunar white glass meeting the latest standards of the Institute of Traffic Engineers with all except the letters obscured by an opaque material. The **DON'T WALK** lens shall be orange glass meeting the latest standards of the I. T. of E. with all except the letters obscured by an opaque material. The aluminum reflector shall be mounted in a cast aluminum housing. One hundred watt traffic signal lamps shall be installed. Signal shall be made weathertight by means of moulded neoprene gaskets between all component parts.

(K) **Lighting and Other Systems.** (1) **Luminaires.** Types and style of luminaires, lamp equipment and transformers shall be as specified in the special provisions or as shown on the plans. All side and end mounted luminaires shall be equipped with two inch slip-fitter. All side mounted incandescent luminaires shall be equipped with porcelain heat barrier bushing except that for multiple type luminaires glass sleeving may be used.

(2) **Flashing Beacons.** Where shown on the plans, flashing beacons shall be installed. Beacon shall be a single unit signal head, conforming to the provisions of Article 87.05(J)(1), with yellow or red lens as shown on the plans. Mounting of beacon shall be as shown on the plans. Flasher shall be motor driven or an electronic device without tubes. Contacts shall be silver or silver alloy not less than $\frac{3}{8}$ " diameter rated at 20 amperes, 115 volts. Flasher shall provide 50 to 60 flashes per minute, with equal on and off intervals, and shall be equipped with a radio interference suppressor, as specified for traffic signal controllers. Workmanship and materials shall be equal to that specified for controllers. Flasher shall be encased in a rain-tight housing. When flashing beacons are installed adjacent to or in conjunction with a traffic signal system, the flasher control shall be installed in the controller cabinet unless otherwise shown on the plans.

(3) **Sign Lighting Fixtures.** These shall be as shown on the plans, or as specified.

(4) **Incandescent Sign Lighting Fixtures.** These shall be of the type shown on the plans. Fixtures shall be provided with 120-volt group replacement multiple lamps of wattage rating as shown on the plans.

(5) **Photo-Electric Controls.** (a) **Types.** These as specified or shown on the plans, shall be one of the following types,

and shall be capable of switching multiple lighting systems directly or of switching series lighting systems through a high voltage controller:

Type I shall consist of a photo-electric unit and a contactor in a single weather-proof housing.

Type II shall consist of a photo-electric unit in a weather-proof housing and a separate contactor located in a traffic signal controller cabinet.

Type III shall consist of a photo-electric unit and a separate contactor, both in weatherproof housings. A switch to permit manual operation of the contactor shall be provided. Switch shall be furnished with an indicating nameplate reading "Auto—Off—Manual" with "OFF" in the center position.

(b) Equipment Details. **(1) Photo-Electrical Unit.** The photo-electric unit shall consist of a light sensitive element connected to control relay, either directly or through a vacuum tube amplifier. The light-sensitive element shall have a spectral response such that it is especially sensitive to north sky illumination and shall have an "on" level adjustment between minimum limits of one and five foot-candles. The unit shall be so designed that a failure of any electronic component will energize the lighting circuit. A time delay shall be incorporated into the unit to prevent operation in the event of brief changes in lighting conditions. The photo-electric unit shall be mounted at the top of the standard designated on the plans and shall be oriented as ordered by the engineer.

(2) Contactor. The contactor shall have contacts rated to switch the specified lighting load and shall be normally open unless otherwise specified. It shall be either the mechanical armature type (indicated by subscript "—a") or mercury-tube type (indicated by subscript "—m") as specified or shown on the plans. The mechanical armature shall consist of an operating coil, a laminated core, a laminated armature, contacts and terminals. Contacts shall be silver alloy. The mercury-tube type shall consist of an operating coil, necessary mercury tubes and terminals. Mercury tubes shall be hermetically sealed and shall contain an inert gas. Contact shall be made either mercury to mercury or between mercury and contacts of an alloy resistant to both arcing and mercury amalgamation.

(3) Contactor Housing. When located externally, the contactor shall be housed in either a suitable NEMA Type 3 rain-tight enclosure with dead front panel and hasp for padlock or in a traffic signal controller cabinet. The rain-tight enclosure shall be mounted on the same standard as the photo-electric unit at a height of approximately 8 feet above the base.

(4) Wiring. Conductors between the photo-electric unit and an external contactor shall be No. 14 AWG and shall be run inside the lighting standard.

(6) Series-Multiple Transformer. Series - multiple transformer shall conform to the following:

(a) Series-multiple transformer shall operate a 110-volt to 125-volt multiple load from a single phase, 60 cycle, 6.6 ampere constant current, series circuit.

(b) The secondary voltage shall have a permissible range from 110 volts at full load to 125 volts at one-quarter load and 130 volts at no load without the use of film cutout.

(c) Transformers shall be insulated and NEMA tested for operation of 5,000-volt circuits and shall carry rated volt-amperes continuously without exceeding 55°C. rise above a 40°C. ambient as measured by change in winding resistance.

(d) The case shall be a Gage 16 brass pole base type, capable of passing through a 9½" x 13" opening. Three brass cable entrance sleeves, 1½" long, shall be brazed to the cover. The sleeves are to be suitable for taped joints without threads or wiping sleeve feature. The unit shall be watertight and filled with a high melting point insulating compound. The core and coils shall be mechanically attached to the case.

(e) Transformer leads shall be equipped with non-hygroscopic material. There shall be two single-conductor primary leads and one two-conductor primary lead and one two-conductor secondary lead extending at least outside of the sleeves.

(f) Transformer rating shall be as indicated on the plans.

(7) **Isolating Transformers and Ballasts.** Type and style of isolating transformers shall be as specified or as shown on the plans. They shall be equipped with non-hygroscopic leads and shall be sealed to insure satisfactory operation under continuous submersion in water. Splices at transformers shall conform to Article 87.06. Where more than one conductor enters a transformer sleeve the insulation and taping shall be applied between the conductors in such a manner as to provide a watertight joint. The splice installation shall be capable of satisfactory operation under continuous submersion in water. When connecting mercury vapor ballasts to multiple circuits, the primary circuit at each ballast shall be connected to the tap nearest the actual line voltage. The voltage shall be measured when all lamps and other loads on the circuit are energized.

(L) **Overhead Conductor Lighting Installation.** (1) **Equipment.** (a) **Luminaire.** Luminaire shall be slipfitter type end mounting, distribution type as shown on the plans, for horizontal operation of the E-H1 mercury vapor lamp, multiple or series as required. Glassware shall be hinged, detachable, have an automatic latch and shall provide a weather-proof seal to the housing with a gasket between. Reflectors shall be one piece aluminum. Housing shall be one-piece aluminum and shall have a suitable means of clamping and leveling the luminaire. Inside house-side deflectors and/or external glare shields of approved type shall be installed when required to do so.

(b) **Lamps.** Lamps shall be mercury vapor E-H1, 400 watt, 21,000 rated initial lumens, BT-37 clear bulb, mogul base, with 7,000 hour rated average useful life.

(c) Lighting Brackets. These shall be constructed to the dimensions as shown on the plans. All brackets shall exceed NEMA and IES standards as to vertical and horizontal deflection. Bracket wiring between luminaire and ballast secondary shall be No. 10 AWG copper, insulated for 600 volts.

(d) Ballasts. These shall be aerial mounted as shown on the plans for the operation of 400 watt E-H1 mercury vapor lamps as follows:

(1) Multiple Operation. Ballasts shall be 115/230 volts, constant wattage type, minus 30°F. starting capacity, 0.98 power factor. Ballast shall hold the lamp wattage to plus or minus 3% of the rated voltage with fluctuations of voltage up to plus or minus 15 volts at 115 volts and plus or minus 30 volts at 230 volts.

(2) Series Operation. Ballast shall be designed for 6.6 amp constant current service, minus 30°F. starting capacity, and 0.88 power factor.

(e) Wood Poles for Highway Lighting. Wood poles shall be 35 foot, Class 6, unless otherwise specified. Poles shall conform to ASA Specifications for wood poles except that a line drawn from the center of the pole at the ground to the center of the pole at the top shall lie within the body of the pole. Poles shall be machine peeled. Poles shall be set a depth of 6 feet measured from the downhill side of the hole. Poles shall be set truly plumb and in line, and shall be thoroughly and firmly tamped. Effort shall be made to keep from damaging the finished surface of the pole and any injury thereof shall be repaired to the satisfaction of the engineer. The following treatments will be used as specified on the plans or special provisions:

(1) Treated poles shall receive full length pressure treatment per AWPA specifications with a 5% pentachlorophenol solution in a petroleum carrier in accordance with Section 51.

(2) Painted poles shall have standard incised butt penta treatment per AWPA specifications. Pole shall receive 2 coats of black paint, conforming to Article 54.04(B)(9), from below ground line to a point 2' above the ground line. The remainder of the pole above ground shall receive one coat of primer and two coats of aluminum paint.

(f) Steel Poles for Highway Lighting. Construction and installation shall conform to the provisions of Article 87.06 and the standard drawing.

(2) Line Material. (a) All hardware shall be as described on the plans, or herein, shall be suitable for the use intended, and shall be galvanized. Hardware shall be installed with lock-nuts, tightly drawn up in a manner to cause the least radio interference.

(b) Insulators for brackets, clevises and upset bolts shall possess characteristics as follows: wet process type, overall dimensions 3" diameter x 3 3/16", 5/8" bolt hole, 7/16 radius wire slot, vertical mounting, wet flashover 14 KV, horizontal mounting wet flashover 17 KV, dry flashover 26 KV, and ultimate mechanical strength 5,000 pounds.

(c) Double upset bolts shall be 9/16" steel with 5/8" rolled threads, 1 1/2" upset to upset, and 4 1/2" threaded insulator end with cotter key.

(d) Insulated brackets shall be primary spool type clevises of the cross arm mounting type .Construction shall be of 1 3/4" x 1/8" steel provided with a 3/4" mounting hole and 5/8" cotter pin for mounting the insulator mentioned in part (b) above. The clevis shall be so designed that the distance from the center of the insulator to the mounting face will be 5 inches.

(e) Insulated swinging clevises shall be of 1 1/2" x 3/16" steel, 5" from 5/8" cotter pin to eye attachment, for 3" insulator and 5/8" eyebolt or eyenut.

(f) Connectors shall be of proper size, material and design for the use intended. Copper-to-copper connectors shall be of high strength silicon bronze, threaded with spacer and nut; aluminum-to-copper connectors shall consist of aluminum alloy bolt and nut with plated copper spacer and plated copper contact with plating removed from contact surfaces to identify copper conductor location.

(g) Insulated tension splices shall have an insulated length of 4", clips for attaching tap wires and shall be of proper size for the wire being installed. Engineer's approval shall be secured before installation. Insulated tension splices shall be used, where required in series installations, with the following general rules:

(1) Splices shall not be located closer than 18" from a support point.

(2) Splices shall not be located in spans crossing a highway, street, railroad or similar condition.

(h) Overhead line conductor shall be as specified on the plans and special provisions. Conductor with cuts, kinks or other injuries shall not be installed. On angle assemblies the conductor shall be placed on the side of the insulator away from the strain and tied in place as shown on the plans. Wire shall be sagged in the presence of the engineer, using tables provided by him. An approved thermometer shall be used for determination of the temperature. The wire shall be gradually pulled up to the required sag, taking care that the wire is free to move at intermediate support points and that the wire is not pre-stretched by pulling beyond the required sag at any time.

(i) **Guys and anchors.** (1) Guys and anchors shall be installed where and as indicated on the plans. Two strain in-

sulators shall be in every guy span. Eyebolts, eyenuts, and anchor rods shall have the thimble type or eye when used on guys. When eyebolts and eyenuts are used on down guys, they shall have the 45° angle type.

(2) Guy Wire shall be $\frac{3}{8}$ " Siemens-Martin, 7 strand, double galvanized with Class B zinc coating in accordance with ASTM A 363, unless otherwise indicated on the plans.

(3) Clamp, 3 bolt, shall be medium duty for the purpose intended. All three bolts shall be tightly drawn up and located as shown on the plans. Alternatives to 3-bolt clamps will be considered but must be approved before use.

(4) Guy protectors shall be 8' long, full round type of Gage 14 galvanized steel.

(5) Insulator, Strain, shall have the following characteristics:

Rated Voltage	4.4
Flashover Voltage: 60 Cy. Dry KV	30
60 Cy. Wet KV	15
Mechanical Strength	12,000
Maximum Cable Size, Inches	$\frac{1}{2}$
Length	$4\frac{1}{8}$
Width	$2\frac{7}{8}$

(6) Anchors and rods shall be of the size and type indicated on the plans. They shall be in line with the strain and shall be installed so approximately 6" of the rod remains out of the ground. The hole, after the anchor has been set in place, shall be backfilled with coarse crushed rock for 2' above the anchor, tamped during the filling. All anchors shall be tamped the full depth of the hole.

87.06 CONSTRUCTION METHODS. (A) All parts of Article 87.05 must be carefully reviewed by the contractor and engineer inasmuch as some construction methods are interspersed therein. Before starting work on existing series street lighting circuits, the contractor shall obtain daily safety circuit clearance from the servicing utility. Cut-out plugs must be pulled and "Men at Work" signs posted at cut-out boxes before any work is done.

(B) **Excavating and Backfilling.** The excavations required for the installation of conduit, foundations, and other appliances shall be performed in such a manner as to cause the least injury to the streets, sidewalks, and other improvements. The trenches shall not be excavated wider than necessary for the proper installation of the electrical appliances and foundations. Excavating shall not be performed until immediately before installation of conduit and other appliances. The material from the excavation shall be placed in a position where the least damage and obstruction to vehicular and pedestrian traffic and the least interference with the surface drain-

age will occur. All surplus excavated material shall be removed and disposed of, within 48 hours, by the contractor, outside the Highway, subject to the satisfaction of the engineer. The excavation shall be backfilled in conformance with Article 45.03 (F). Excavations, after backfilling, shall be kept well filled and maintained in a smooth and well-drained condition, until permanent repairs are made. At the end of each day's work and at all other times when construction operations are suspended, all equipment and other obstructions shall be removed from that portion of the roadway open for use by public traffic. All excavation shall be closed, and sidewalks, pavement and landscaping restored at each intersection prior to opening any other intersection, unless it is otherwise approved by the engineer. Excavations in the street or highway shall be performed in such a manner that not more than one traffic lane is restricted in either direction at any time.

(C) Removing and Replacing Improvements. Improvements such as sidewalks, curbs, gutters, pavement, bituminous surfacing, base material, and any other improvements removed, broken, or damaged by the contractor, shall be replaced or reconstructed with the same kind of materials as found on the work or with materials of equal quality. The new work shall be left in a serviceable condition satisfactory to the engineer. Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed as above specified. The outline of all areas to be removed in Portland cement concrete sidewalks and in pavements shall be cut to a minimum depth of $1\frac{1}{2}$ " with an abrasive type saw prior to removing the sidewalk and pavement material. Cut for remainder of the required depth may be made by a method satisfactory to the engineer. Cuts shall be neat and true with no shatter outside the removal area.

(D) Foundations. Foundations for posts, standards, installation of detectors and pedestals shall be Class "DD" Portland cement concrete, conforming to the applicable requirements of Section 46. In placing concrete foundation for detectors, concrete shall be worked up between the channels by mechanical vibrating methods. The detector pad shall be removed and a $\frac{3}{4}$ " inspection hole shall be provided at one-foot intervals, placed uniformly along each side of the center line of the pan. Detector frame and concrete shall be finished flush and true with the pavement surface. The bottom of concrete foundations shall rest on firm ground. Foundations shall be poured "in the solid" and monolithically where practicable. For posts, standards, and pedestals, the top two inches shall be poured after the post, standard or pedestal is in proper position. The exposed portions shall be formed to present a neat appearance. Forms shall be true to line and grade. Tops of footings for posts and standards, except special foundations, shall be finished to curb or sidewalk grade or as ordered by the engineer. Forms shall be rigid and securely braced in place. Conduit ends and anchor

bolts shall be placed in proper position and to proper height, and shall be held in place by means of a template until the concrete sets.

Plumbing of standards shall be accomplished by adjusting nuts before the foundation is finished to final grade. Shims or other similar devices for plumbing or raking will not be permitted. Both form and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set. Ordinary surface finish shall be applied to exposed surfaces of concrete. Where obstructions prevent construction of planned foundations, the contractor shall construct an effective foundation satisfactory to the engineer. Posts, poles, standards, and pedestals, except concrete pedestals cast in place, shall not be erected until the foundation has set at least 72 hours, and shall be plumbed or raked, as ordered by the engineer.

(E) Conductors and Wiring. All conductors shall be run in conduit except where run inside poles. Where signal conductors are run in lighting standards containing high voltage street lighting conductors, the signal conductors shall be encased in flexible or rigid metal conduit.

Wiring shall conform to appropriate article of the Code. Wiring within cabinets, junction boxes, etc., shall be neatly arranged and laced. Powdered soapstone, talc, or other approved lubricant shall be used in placing conductors in conduit. All signal light conductors, except branch neutrals, shall be run continuously from a terminal block located in a cabinet, compartment, or signal head, to a similarly located terminal block, without splices. Branch signal light neutrals and detector commons may be spliced at pull boxes.

Sufficient signal light conductors shall be provided to perform the functional operation of the signal system and in addition thereto, two spare conductors of size equal to the largest light conductor in the run, shall be provided throughout the signal light system, except as noted on the plans. At least 5' of slack shall be left for each conductor at each standard (signal or lighting or combined), and at least 2' of slack at each pullbox.

Where pressure detectors are to be installed, a separate hot conductor shall be run from the controller cabinet to each detector element. A common neutral conductor, separate from the signal light circuit neutral, shall be used for all 12-volt circuits, including the pressure detector and pedestrian push-button circuits.

Where isolating transformers are not to be used, series lighting cable shall be run without splices from luminaire to luminaire and from service to luminaire. Multiple lighting conductors may be spliced in bases of standards or pullboxes adjacent thereto.

Conductors shall be jointed by a "Western Union" type splice or by the use of an approved connector. Connectors shall

be used for splicing all conductors No. 8 AWG, or larger. All splices shall be soldered by the pouring or dipping method.

Conductor insulation shall be well penciled, trimmed to conical shape, and roughened before applying splice insulation. Splice insulation shall consist of layers of thermoplastic electrical insulating tape not over 0.007" thick conforming to Federal Specification MIL-I-7798, applied to a thickness equal to and well lapped over the original insulation, except that on high voltage and multiple lighting conductor splices, two layers of synthetic oil resistant rubber tape conforming to ASTM D 119 shall be applied over the conductor before placing the thermoplastic tape. The splice shall then be well covered with at least two layers of asphaltic impregnated open mesh fabric tape, and a coating of high grade insulating paint or similar material. At least 2' of slack shall be left for each conductor at each splice.

Where multi-conductor cable is used, all conductor splices shall be neatly cabled together and covered with hot vulcanized layer of material suitable to bond with the cable covering, and when finished, the joint shall present a covering built up level with original cable covering and shall be completely waterproof. An approved type of watertight splicing box may be used in lieu of vulcanizing.

When conductors and cables are pulled into the conduit, all ends of conductors and cables shall be taped to exclude moisture, and shall be so kept until the splices are made or terminal appliances attached. Ends of spare conductors shall be taped.

A small permanent band or bands, on which the circuit, designation number, and phase are stamped, in the order named, using the code letters given in Article 87.05(F) (4) shall be securely attached near the end of each conductor, at each controller, switch, standard, or pull box, where conductors are separated. Where circuit and phase are not clearly indicated by conductor insulation, additional bands shall be used.

(F) Bonding and Grounding. Metallic cable sheaths, conduit, and metal poles and pedestals shall be made mechanically and electrically secure to form a continuous system, and shall be effectively grounded. Bonding and grounding jumpers shall be copper wire or copper strap of the same cross-sectional area as No. 6 AWG, for series lighting systems and No. 8 AWG for all other systems. Bonding of standards and pedestals shall be by means of a bonding strap attached to an anchor bolt or a 3/16", or larger, brass or bronze bolt installed in the lower portion of the shaft. One side of secondary circuit of series-multiple transformers shall be grounded. Grounding of conduit and neutral at service point shall be accomplished as required under the code or this section, except that grounding conductors shall be No. 6 AWG, or equal.

At each multiple service point, a ground electrode shall be furnished and installed. Ground electrodes of steel or iron

shall be one piece lengths of galvanized rod or pipe at least $\frac{3}{4}$ " diameter. Electrodes of non-ferrous materials, or their approved equivalent, shall not be less than $\frac{1}{2}$ " diameter. Ground electrodes shall be installed in accordance with the Code. The service equipment shall be bonded to the ground electrode by use of a ground clamp and No. 6 AWG copper wire, or equal, enclosed in a $\frac{1}{2}$ " diameter conduit or hardwood molding. Where conduit system parallels, or crosses, a permanent water system in accessible areas, grounding jumpers shall be installed at intervals not exceeding 500 feet. Grounding to a water system at or near the service point will be accepted in lieu of the driven ground rod.

(G) Service Connections. Service points shown on the plans are approximate only. The contractor shall determine exact locations from the serving utility. Where the contractor is required to install the lower section of riser on a utility pole, the location of riser shall be determined by the utility.

87.07 PAINTING. Paint may be applied at any time approved by the engineer. Standards, frames, signal bridges, fittings and other applicable metal parts shall be thoroughly clean when paint is applied. Breaks, abrasions and damaged areas on galvanized surfaces shall be painted with zinc chromate primer and two coats of aluminum paint conforming to Article 54.04, Parts (B) (7) and (B) (3) respectively. If the manufacturer has applied an approved prime coat of paint, and it is not damaged, field primer will not be required.

Galvanized surfaces, which are to be painted, shall be treated in accordance with Article 54.04 unless the galvanizing is of a type receptive of paint. The first coat shall be zinc chromate primer, inside and outside of applicable fixtures.

Back plates shall receive a coat of primer.

After erection, all exterior surfaces shall be examined for damaged primer and such damaged surfaces shall be given a spot coat of primer.

Metal posts, poles, pedestals, standards and bases below the bottom of signal heads shall be given a minimum of two coats of signal post yellow of a shade approved by the engineer. Final coat shall show even solid color.

Metal parts above the bottom of the base of the signal heads, on poles which are not galvanized or when ordered by the engineer, shall be finished with two coats of dark olive green enamel, except that painting of signal heads which have been factory enameled in black or dark olive green, and are in good condition, may be omitted. Interior of hoods and front faces of back plates shall be finished with two coats of flat black enamel.

Non-galvanized metal lighting standards (without signals), illuminated sign bridges, poles and frames shall be finished

with two coats of dark olive green enamel or aluminum as directed by the engineer.

Standards galvanized full length inside and outside, in conformance with ASTM A 123, will not require painting except that standards used for traffic signals shall be painted yellow as specified above.

Controller cabinets shall be painted dark olive green or aluminum as directed by the engineer.

No more than one day's supply of paint shall be mixed at one time.

Conduit and conduit fittings above ground shall be given one coat of primer and one coat of enamel conforming to the color of the adjacent standard or pedestal. Concrete guard posts shall be painted with aluminum or yellow signal post enamel as ordered by the engineer. Treated wood guard posts shall not be painted.

Pedestrian push button posts shall be painted with yellow signal post enamel.

All paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators. The work shall be done in a neat and workmanlike manner, and the engineer reserves the right to require the use of brushes for the application of paint, should the work done by the paint spraying machine prove unsatisfactory or objectionable.

87.08 FIELD TEST. Prior to completion of The Work, the contractor shall cause the following tests to be made on all traffic signal and lighting circuits, in the presence of the engineer.

- (1) Test for continuity of each circuit.
- (2) Test for grounds in each circuit.
- (3) A megger test on each circuit between the circuit and ground. The insulation resistance shall not be less than the values specified in Section 11.19 of the code.
- (4) A functional test in which it is demonstrated that each and every part of the system functions as specified or intended herein.
- (5) The contractor shall perform, on high voltage series lighting circuits, a high voltage test consisting of an 8,400-volt, 60 cycle alternating current between the conductors and ground for five consecutive minutes with the two ends of the circuit connected together. The initially applied voltage shall be applied to the entire completed circuit and shall not be greater than the rated voltage of the cable and the rate of increase shall be approximately uniform and not over 100 percent in 10 seconds nor less than 100 percent in 60 seconds. The voltage shall be increased to the value of 8,400 volts root mean square and held at this value for five minutes.

When approved by the engineer, the contractor may, in lieu of the above 8,400-volt test, perform a high voltage series lighting test consisting of the open circuit voltage of the connected constant current transformer between the conductors and ground.

Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the contractor in a manner approved by the engineer, and the same shall be repeated until no fault appears.

87.09 SALVAGING AND REINSTALLING ELECTRICAL EQUIPMENT. **(A) Salvaging Electrical Equipment.** Where shown on the plans or ordered by the engineer, existing electrical equipment including controllers, cabinets, signal heads, luminaires, standards, pull boxes, and detector frames and pads, etc., shall be removed, cleaned, salvaged and stockpiled or reinstalled as specified.

Unless otherwise specified, underground conduit, conductors, bases and detector frames not reused shall become the property of the contractor and shall be removed, except, if not interfering with other construction, said materials, may with the written approval of the engineer, be abandoned in place.

Care shall be exercised in removing and salvaging electrical equipment so that it will remain in its original form whenever possible. The contractor will be required to replace, at his own expense, any of the above-mentioned electrical equipment, which, as determined by the engineer, has been damaged or destroyed by reason of his operation.

(B) Reinstalling Salvaged Electrical Equipment. When salvaged electrical equipment is to be reinstalled, the contractor shall furnish and install all necessary materials and equipment, including anchor bolts, nuts, washers, concrete, etc., required to complete the new installation.

87.10 METHOD OF MEASUREMENT. When a lighting or signal system is bid on a lump sum basis, measurement will be made as a complete system.

Items which are bid on a lineal foot basis will be measured to the nearest lineal foot in place, ready for use.

Items which are bid on a unit basis will be counted as such.

87.11 BASIS OF PAYMENT. When a lighting or signal system is bid on a lump sum basis, payment will be made for a complete system.

When items are bid on a lineal foot basis, payment will be made for the total number of measured lineal feet of the item.

When items are bid on a unit basis payment will be made for the counted quantity.

Payment for any and all work and materials bid under this section shall include everything necessary to complete The Work in accordance with the plans and specifications and as directed.

Payment for various types of signals will include "mounting".

Arabic numbers (2, 12) will be used in proposals instead of roman numbers (II, XII) but the meaning will be the same.

SECTION 88

SIGNS AND SIGNING

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88.01 DESCRIPTION. "Signs and Signing" shall consist of furnishing all materials, making and preparing all signs and performing all work incidental thereto, including erection, installation, fittings, posts, foundations, structures and other incidentals, in accordance with the plans, standard drawings, specifications and special provisions and as may be directed.

It is the intent of these specifications to comply with the standards and requirements of the AASHO manuals on "Signing and Pavement Marking for the Interstate Highway System" and "Manual on Uniform Traffic Control Devices for Streets and Highways"; both as approved by the Bureau of Public Roads.

88.02 MATERIALS FOR SIGNS. (A) **Sheet Aluminum.** Sheet aluminum shall be aluminum alloy conforming to Aluminum Association alloy designation 6061-T6 (hereinafter abbreviated to AA6061-T6). The thickness of sheet material used for aluminum signs shall be as set forth in Table A.

TABLE A
SINGLE POST CENTERLINE MOUNTING

Sign Width	Thickness
(Normal to Post)	of Sheet Metal
Less than 20 inches	0.063 Inch
20 to 30 inches inclusive	0.080 Inch
31 to 48 inches inclusive	0.100 Inch

TWO POST MOUNTING

(Posts at fifth points of sign width)

Less than 36 inches	0.063 Inch
37 to 48 inches inclusive	0.080 Inch
49 to 60 inches inclusive	0.100 Inch
61 to 72 inches inclusive	0.125 Inch
73 to 96 inches inclusive, with two $1\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{8}''$ angle girts inside posts attached with $5/16''$ machine screws on $12''$ centers	0.100 Inch

(B) Extruded Aluminum. Aluminum extrusions shall conform to AA6063-T6 with a minimum weight of 2.65 lb./ft. for the 12" widths and a minimum weight of 1.10 lb./ft. for the 6" widths. No more than one 6" width shall be used in any one sign. These extrusions will be ALCOA System, "Type A", bolted, or Reynolds interlocking type, System "D", or equal.

(C) Plywood. All sign faces that are specified to be made of plywood shall be constructed of overlay, high density Douglas Fir plywood conforming to the requirements as set forth in "Commercial Standard 45 for Douglas Fir Plywood". The plywood shall be B-B high density overlay, 60/60 with amber overlay both sides and of the thickness shown on the plans.

(D) Steel and Iron Posts. **(1) General.** The size and shape, including any holes or cuts, shall conform to applicable standard drawings and special provisions. All required holes and cuts shall be made prior to galvanizing or painting. When holes or cuts are made in the field, the bared areas shall be given one coat of metal primer and two coats of aluminum paint. Galvanized posts shall be treated in accordance with ASTM A 123 with a coating averaging not less than 2 ounces per square foot of actual surface. Painted posts shall not be galvanized but shall be painted with one coat of zinc chromate primer or red lead and at least one coat of aluminum paint. All paints and application shall conform to Section 54.

(2) Structural Steel Posts. **(a) Steel Structural Posts.** Steel structural posts having a nominal weight of more than three pounds per lineal foot shall conform to ASTM A 7. These will be bid as "Steel Structural Sign Posts".

(b) Steel U Sign Posts. Steel posts formed into a "flying U" shape, having a nominal weight of three pounds or less per foot, shall conform to Commercial Standard 184 as published by the U. S. Department of Commerce. These will be bid as "Steel U Sign Posts".

(3) Wrought Iron Posts. Wrought iron posts shall conform to ASTM A 72 (AASHO M 101); black or galvanized; standard weight, extra strong or double extra strong; all as specified.

(4) Tubular Steel Posts. These posts shall conform to ASTM A 53, black or galvanized as specified.

(E) Aluminum Posts. Extruded standard structural and rolled standard structural shapes shall conform to AA 6062-T6 or 6061-T6. Extruded tubular posts shall conform to AA 6062-T6 or AA 6063-T6.

(F) Treated Timber Posts. All treated timber posts shall be of construction grade, S4S, pressure treated with a 5% solution of pentachlorophenol in accordance with Section 51. Length and size shall be as shown in the plans. All cutting, trimming and boring shall be done prior to treatment. Treatment shall result in a uniform color between posts as well as along the length of an individual post. When posts have been damaged or when it becomes necessary to cut or bore into pieces after treatment, injuries, cuts, or holes shall be poured full of an approved hot preservative or swabbed with two applications of hot preservative.

(G) Treated Timber Poles. All treated timber poles shall conform to A.S.A. specifications and dimensions and shall be the species listed in Group IV, V or VI. All poles on any one project shall be of the same specie. Length and size shall be as designated on the plans. All poles shall be machine peeled and full-length pressure-tested with a 5% solution of pentachlorophenol in accordance with Section 51. The top half of each pole shall be gained on the sign face a minimum width of two inches.

All cutting, trimming and boring shall be done prior to treatment.

When posts have been damaged or when it becomes necessary to cut or bore into pieces after treatment, injuries, cuts, or holes shall be poured full of an approved hot preservative or swabbed with two applications of hot preservative.

(H) Overhead Structures. Overhead sign structures shall be metal structures capable of supporting the signs and meeting the clearance requirements shown on the plans and designed according to "Specifications for the Design and Construction of Structural Supports for Highway Signs" as published by AASHO-1961. The contractor may propose other types of structures than shown on the plans; however, he must submit six sets of shop drawings for any and all structures he proposed to build to the engineer for approval. No fabrication for any structure shall begin until the contractor receives an approved set of shop drawings. All overhead sign structures shall be designed so that brackets may be attached in the future for the purpose of supporting lighting fixtures and walkways.

The foundations of the overhead sign structures shall be as shown on the plans or, if an overhead structure is proposed that will not fit the type of foundations as shown on the plans, the contractor may submit an alternate foundation with the

shop plans of the type of overhead sign structure he proposed to erect.

Steel structures shall be painted with one coat of red lead or zinc chromate primer and two coats of aluminum paint. All paints and their application shall conform to Section 54.

(I) Concrete. Concrete for steel sign post foundations shall be class "A", conforming to Section 46. Concrete may be mixed in approved transit mixers. No hand mixing will be allowed. An air-entraining agent shall be added to all concrete in the foundations.

(J) Reflective Sheeting. **(1) General.** The reflective sheeting shall consist of spherical lens elements embedded within a transparent plastic having a smooth, flat outer surface. The sheeting shall be weather resistant and have a protected pre-coated adhesive backing.

(2) Photometric. **(a) Background.** The reflective sheeting for backgrounds and screened signs shall have the following minimum brightness values at 0.2° and 0.5° divergence expressed as average candlepower per foot candle per square foot of material. Measurements shall be conducted in accordance with standard photometric testing procedures for reflex reflectors of the S.A.E.

	Silver White		Yellow		Red		Blue			
Angle of Incidence	.2	.5	.2	.5	.2	.5	.2	.5	.2	.5
0°	40	17	25	8	10	5	5	2	5	3
15°	32	13	20	7	7	4	3.5	2	3.5	2
30°	20	10	10	4	5	2	2.2	1.0	2.2	1.0
45°	8	5	4	1.2	1.0	0.5	0.7	0.3	0.7	0.3

(b) Applied or Demountable Copy. Reflective sheeting for applied or demountable cutout letters, numerals, symbols and borders shall be silver white having a minimum brightness 180% that specified above.

(c) Brightness. The brightness of the reflective sheeting, totally wet by rain, shall not be less than 90% of the above values. Wet performance measurements shall be conducted in conformance with Standard Rainfall Test specified in Military Specification MIL-T13689A, or as amended.

(3) Color. The diffuse day color of the reflective sheeting shall meet the following requirements when tested in accordance with ASTM E 97:

DAY COLOR FOR CIE STANDARD SOURCE C

COLOR	C.I.E. CHROMATICITY COORDINATE (x,y) LIMIT			(y) (Percent) REFLECTANCE LIMIT
Silver-White	y=	1.118x	-0.030	Min. 40.0
	y=	2.125x	-0.344	
	y=	-0.986x	+0.726	
Yellow	y=	1.024x	+0.002	31.5 to 39.5
	y=	0.715x	+0.097	
	y=	-1.012x	+0.968	
Red	y=	0.097x	+0.288	8.0 to 10.8
	y=	0.019x	+0.309	
	y=	-0.991x	+0.941	
Blue	y=	1.619x	-0.190	0.93 to 1.63
	y=	1.317x	-0.090	
	y=	-1.558x	+0.394	
	y=	-1.575x	+0.310	
Green	y=	-0.253x	+0.395	4.1 to 6.5
	y=	-0.686x	+0.525	
	y=	-7.300x	+1.544	
	y=	-6.940x	+1.297	

(4) Adhesive. The reflective sheeting shall include a pre-coated tack free adhesive designed for mechanical application and which will adhere to prescribed surfaces only when activated by heat or solvent. For manual application of sign borders, sign repair, emblems and vehicle marking the pre-coated adhesive shall be pressure sensitive. The pre-coated adhesive shall not require additional adhesive coats on the reflective sheeting or application surface.

The adhesive coated sheeting shall form a durable bond to smooth, corrosion and weather resistance surfaces and adhere securely at temperatures of -30° to 200°F. The pre-coated adhesive, 48 hours after application, shall be: tough enough to resist scuffing and marring during handling; elastic enough at low temperatures to resist shocking off when struck at -10°F. without appreciable decrease in adhesion; vandal resistant and strong enough to resist peeling the reflective sheeting from the application surface when a 5 lbs./inch width force is applied as outlined in ASTM D 903. The pre-coated adhesive shall have no staining effect on the reflective sheeting and must be mildew resistant.

(5) Film. **(a) General.** The reflective sheeting shall be sufficiently flexible to be easily cut to shape and permit application over and conformance to moderate, shallow embossing characteristic of certain sign borders and symbols. Conditioned for 48 hours, the tensile strength of the sheeting shall be 5 to

15 lbs./inch width when tested in accordance with ASTM D 828 with 5-20% elongation (ASTM D 987). Following liner removal, the reflective sheeting shall not shrink more than $\frac{1}{32}$ " in 10 minutes nor more than $\frac{1}{4}$ " in 24 hours in any dimension per 9" square at 75°F. and 50% R.H.

The sheeting, when applied according to manufacturer's recommendations to cleaned and etched 0.015" x 2" x 8" aluminum, conditioned (48 hours) and tested at 72°F. and 50% R.H., shall be sufficiently flexible to show no cracking when bent around a $\frac{3}{4}$ " mandrel.

(b) Surface. The sheeting surface shall be smooth and flat, facilitate cleaning and wet performance, and exhibit 85° gloss-meter rating of not less than 35 (ASTM D 523). The sheeting surface shall be readily processed and compatible with recommended transparent and opaque process inks and show no loss of the color coat with normal handling, cutting and application. Following accelerated exposure as outlined in Part (J) (6) of this Article no process inks shall be removed when tested by scratching through the ink surface, applying cellophane tape over the scratched area, and removing the tape with one quick motion.

The sheeting shall permit cutting and color processing at temperatures of 60-100°F. and relative humidities of 20-80%. The sheeting shall be heat resistant and permit force curing of unapplied sheeting at temperatures up to 150°F. and up to 200°F. on applied sheeting. The sheeting surface shall be solvent resistant and may be cleaned with gasoline, VM&P Naphtha, mineral spirits, turpentine, methanol, and xylol.

(c) Lens Elements. The reflective sheeting shall possess stable and durable spherical lens elements which, following extraction, shall show no deterioration following submersion in a 5N solution of sulphuric acid (H_2SO_4) for 30 minutes at 72°.

(d) Protective Liner. The protective liner attached to the adhesive shall be removed by peeling without soaking in water or other solvents and shall be easily removed after accelerated storage for four hours at 150°F. under weight of 2.5 pounds per square inch.

(6) Durability. Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and following cleaning shall show no appreciable discoloration, cracking, crazing, blistering, or dimensional change and not less than 80% of the specified minimum brightness values when exposed to accelerated weathering for either 175,000 Langleys (approximately 1 year), south facing, unprotected at 45° in south Florida; or 12,000 hours Atlas Twin arc weathering in accordance with ASTM D 822.

The sheeting surface may be readily refurbished by cleaning and clear over-coating in accordance with the manufacturer's recommendations.

(7) General Characteristics and Packaging. The reflective sheeting as supplied shall be of good appearance, free from ragged edges, cracks, scales and blisters and shall be furnished in both rolls and sheets. There shall be no more than four splices per 50-yard roll. Splices shall be taped butt splices with less than 1/64" gap. Splices shall be suitable for application as supplied.

Rolls shall be packed individually and snugly in fiberboard boxes in such manner that no damage or defacement may occur to the reflective sheeting during shipment or storage. Rolls 3" in width to 24" in width shall be packed in corrugated cartons of min. 275 Test. Rolls 25" in width and above shall be packed in corrugated cartons of min. 350 Test. Rolls wider than 6" and 10 yards or more in length shall be supported and suspended by the roll core within built-up and reinforced corrugated pads. Rolls shall be protected with creased traps of corrugated board.

Cut sheets shall be packaged flat between pressed board panels of the same dimensions as the sheets and shall be so packed as to prevent damage or defacement during shipment or storage.

The reflective sheeting as supplied may be stored at temperatures up to 100°F. for periods up to one year.

(K) Demountable Letters, Symbols and Accessories. **(1) General.** These materials shall be the type specified by the plans. Type A, Type B or Type C, as described in following parts, will be used. All shall be a removable cutout type.

(2) Type A Letters-Acrylic Plastic Reflectors. **(a) General Description.** Reflectorized cutout letters, digits, and alphabetic accessories shall consist of acrylic plastic prismatic reflectors supported by embossed aluminum frames.

(b) Design and Fabrication. Letter design shall be the Federal Standard Alphabet Series "D", modified to accommodate the required reflectors. All items, except border strips, shall be fabricated from 0.040" sheet aluminum. Border strips shall be fabricated from 0.032" sheet aluminum. Mounting holes shall be provided within the frames to permit the use of screws, rivets, or other common fasteners. The size and spacing of reflector holes shall be such as to afford maximum night legibility and visibility to the finished cutout figure.

(c) Finishing. After metal fabrication has been completed, the finishing process shall be as follows: Aluminum frames shall be degreased, etched, neutralized, or so treated as to assure adherence of enamel paint. After treating, frames shall be finished with a good quality of metal enamel paint.

(d) Acrylic Plastic Reflectors. **(1) Manufacturer.** The reflectors shall be acrylic plastic and bidder shall specify the

manufacturer of the raw material and the identification number of the particular molding company to be furnished. Two acceptable formulations are:

Manufacturer	Trade Name	Type of Molding Compound
E. I. duPont deNemours & Co. Inc.	Lucite	RM-140
Rohm & Haas Co.	Plexiglas	V

The reflectors shall consist of a clear and transparent plastic face, (herein referred to as the lens) and an opaque plastic back of identical material fused to the lens under heat and pressure around the entire perimeter to form a homogeneous unit permanently sealed against dust, water, and water vapor. The reflector shall be colorless or amber.

The lens shall consist of a smooth front surface free from projections or indentations other than for identification and a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light. The manufacturer's trade mark shall be molded legibly into the face of the lens.

(2) Optical Requirements. The following definitions are established for the purpose of testing optical performance, as designated herein. "Entrance Angle" shall mean the angle at reflector between direction of light incident on it and direction of reflector axis. "Observation Angle" shall mean the angle at reflector between observer's line of sight and direction of light incident on reflector. "Specific Brightness" shall mean candle-power returned at the chosen observation angle by a reflector per square inch of reflecting surface for each foot-candle of illumination at the reflector.

The specific brightness of each reflector intended for use in cutout letters, symbols and accessories shall be equal to or exceed the following minimum values with measurements made with reflectors spinning. Failure to meet the specific brightness minimum shall constitute failure of the reflector being tested; failure of more than two reflectors out of fifty subjected to test shall constitute failure of the lot.

Observation Angle Minutes	Entrance Angle Degrees	Specific Brightness Candlepower/Square Inch/Foot-Candle
6	0°	14.0
6	20°	5.6
10	0°	10.0
10	20°	4.0
20	0°	7.0
20	20°	2.8

For yellow reflectors, the specific brightness minimum shall be 60% of the value shown for crystal.

(3) Testing Procedure. The reflex reflector to be tested shall be located at a distance of 100 feet from a single uniformly bright light source having an effective diameter of 2 inches; the light source shall be operated at approximately normal efficiency. The return light from the reflector shall be measured by means of a photo-electric photometer having a minimum sensitivity of 1×10^{-7} foot-candles per mm scale division.

The photometer shall have a receiver aperture 0.5" diameter, shielded to eliminate stray light. The distance from light source center to aperture shall be 2.1" for a 6 minute observation angle, 3.5" for a 10 minute angle, and 6.9" for a 20 minute observation angle. During testing the reflectors shall be spun so as to average orientation effect.

If a test distance other than 100 feet is used, the source and aperture dimensions and the distance between source and aperture shall be modified in the same proportion as the test distance.

(4) Durability. The following test shall be used to determine if a reflector is adequately sealed against dust and water: Submerge 50 samples in water at room temperature. Subject the submerged samples to a vacuum of five inches gage for five minutes. Restore atmosphere pressure and leave samples submerged for five minutes, then examine the samples for water intake. Failure of more than 2% of the number tested shall be cause for rejection.

Three reflectors shall be tested for four hours in a circulating air oven at 175°, plus or minus 5°F., to determine heat resistance. The test specimens shall be placed in a horizontal position on a grid or perforated shelf permitting free air circulation. At the conclusion of the test, the samples shall be removed from the oven and permitted to cool in air to room temperature. The samples, after exposure to heat, shall show no significant change in shape and general appearance when compared with unexposed control standards. No failures will be permitted.

(5) Sampling Procedure. For qualification purposes only, the 53 samples required for all of the tests set forth in this specification may be submitted by the manufacturer. For acceptance purposes, the 53 samples will be selected at random by the purchaser from each shipment. Sample lot and acceptance practice will be the same regardless of the size of the shipment, unless specified otherwise.

(6) Packaging. Each cutout figure, completely assembled with reflectors, shall be supplied in an individual package with contents marked thereon.

(3) Type B Letters—White Removable Legends. (a) General Description. Removable reflectorized legends shall consist of acrylic plastic prismatic reflectors supported by por-

celanized aluminum frames. The letter and numeral design shall conform to Part (K) (2) (b). All spacing of the legend shall conform to the spacing recommended by the manufacturer of the legend unless otherwise indicated.

(b) Design and Fabrication. All items for procelain-aluminum frames, except route shields, border strips and corners, shall be fabricated from .040 inch 6061 sheet aluminum No. 1 enameling sheet (B 209, alloy GS11A-T6). Route shields, border strips and corners, shall be fabricated from .032 inch 6061—No. 1 enameling sheet (B 209, alloy GS11A-T6).

Mounting holes shall be provided within the frames to permit the use of the mounting hardware specified. There shall be a sufficient number of mounting holes to insure a firm attachment of the frames to the sign and to hold the reflectors firmly in the reflector holes.

The size and spacing of reflector holes shall be such as to afford the maximum night legibility and visibility to the finished cutout figure. After metal fabrication has been completed, the aluminum frames shall be finished in white procelain enamel measuring 40 to 60 units at 45 degrees on a photovolt meter. Porcelain finish shall be applied in conformance to specifications of the Porcelain Enamel Institute, Designation A.L.S. 105.

(c) Reflectors. These shall conform to Part (K) (2) (d) (1).

(d) Optical Requirements. These shall be as set forth under Part (K) (2) (d) (2) (a).

(e) Specific Brightness. The specific brightness of each reflex reflector shall equal or exceed the following minimum values, regardless of reflector orientation. Failure to meet the specific brightness minimum shall constitute failure of the reflector being tested; failure of more than two reflectors out of fifty subjected to test shall constitute failure of the lot.

Observation Angle Minutes	Entrance Angle Degree	Specific Brightness Candle Power/Square Inch/foot-candle
10	0°	3.4
10	20°	1.4
20	0°	2.8
20	20°	1.0

(f) Reflector Durability. This shall conform to Part (K) (2) (d) (4).

(g) Reflector Sampling Procedure. This shall conform to Part (K) (2) (d) (5).

(h) Mounting Hardware. Aluminum blind rivets shall be used to mount the legend on extruded aluminum signs. The rivets shall be of the design, strength and type recommended by the manufacturer of the legend. Round headed aluminum wood screws $\frac{1}{8}$ " x $\frac{5}{8}$ " shall be used to mount the legend on plywood signs. The screws shall be of the alloy recommended by the manufacturer of the legend.

(4) Type C Letters—Reflective Sheeting. **(a) General Description.** The silver-white letters, numerals, symbols and borders shall be of adhesive coated reflective sheeting permanently adhered to embossed aluminum backing. The reflective sheeting shall consist of spherical lens elements embedded within a transparent plastic having a smooth, flat outer surface. Letter and number design shall conform to Part (K) (2) (b).

(b) Photometric. The reflective sheeting shall have the following minimum brightness values expressed as average candlepower per foot candle per square foot of material. Measurements shall be conducted in accordance with standard photometric testing procedures for reflex reflectors of the Society of Automotive Engineers.

Angle of Incidence-Degrees	Silver-White			
	Divergence	Angle-Minutes	12	30
0			72.0	30.6
15			57.6	23.4
30			36.0	18.0
45			14.4	9.0

The brightness of the reflective sheeting, totally wet by rain, shall not be less than 90% of the above values. Wet performance measurements shall be conducted in conformance with standard rainfall test specified in Military Specification MIL-R-13689A.

(c) Color. Diffuse color requirements shall conform to Part (J) (3) for Silver-White.

(d) Adhesive. Adhesive qualities shall conform to Part (J) (4).

(e) Durability. Durability shall conform to Part (J) (6).

(f) Fabrication. The reflective sheeting shall be mechanically applied to the properly prepared aluminum with the equipment and in a manner prescribed by the sheeting manufacturer.

Letters, numerals and symbols shall be .040" thick aluminum sheet of 3003 H14 alloy; borders shall be .032" thick aluminum sheet of 6061 T6 alloy. Aluminum shall be properly degreased and etched or treated with a light, tight, amorphous chromate type coating and all units shall have an embossed height of approximately $\frac{1}{8}$ inch.

Spacing of mounting holes for screws, bolts, or rivets shall be determined by the character, size and shape and, in no case, shall be more than 8" on center.

Completed demountable letters, numerals, symbols and borders shall be dip coated with a full glossy coat of finishing clear as specified and supplied by the sheeting manufacturer.

(g) General Characteristics and Packaging. The finished letters, numerals, symbols and borders shall show careful workmanship and be clean cut, sharp and have essentially a plane surface.

The manufacturer shall certify that all letters, numerals, symbols and borders furnished conform to this specification and will replace or repair without cost all which fail to meet these requirements.

Letters, numerals, symbols and borders shall be packaged in such a manner as to insure their arrival at destination in undamaged condition. Materials which become wet in storage or shipment will be rejected.

(L) Paints. All paints shall be as specified and shall conform to Article 54.04 Sampling and Testing. They shall be produced by an experienced, properly equipped manufacturer who has prior experience in manufacturing paints of the general character specified and who can cite applications, other than sample panels, of paint of this general character on which satisfactory service has been rendered by his paint for a period of not less than five years. All paints used, when compared in natural day-time light, shall match the standard interstate colors prescribed by AASHO. Paint used over reflectorized backgrounds shall be in complete conformance with recommendations of the manufacturer of the reflective sheeting used.

(M) Hardware. Machine bolts, washers, nuts and lock washers used for erection of aluminum sheet and plywood signs shall be galvanized steel, stainless steel, cadmium plated steel or aluminum alloy conforming to AA 2024-T4. Galvanizing shall be in accordance with ASTM A 153. Hardware for erection of aluminum extrusions shall be according to the manufacturers recommendations. Screws used for fastening letters to signs shall be according to the letter manufacturers recommendations.

88.03 FABRICATION OF SIGNS. **(A) Aluminum Signs.** All aluminum signs that do not have reflectorized background shall have a porcelain enamel background.

(1) Porcelain Enamel Background. The sign face shall be finished in porcelain enamel according to the tentative specification for porcelain enamel on aluminum P.E.I. ALS-105(57). The sign background shall be applied to the edge of extrusions a sufficient distance so that no aluminum surface is visible as the face of the completed sign is viewed from the front.

(2) Reflectorized Background. Reflectorized sheeting shall be applied to the sign face by an approved vacuum applicator or continuous roll applicator using a combination of heat and vacuum or pressure. The preparation of the aluminum surface and the application process shall be in complete conformance with the recommendations of the manufacturer of the reflective sheeting used.

(B) Plywood Signs. All plywood signs that do not have a reflectorized background, shall have a baked enamel background.

(1) Baked Enamel Background. The sign face and all edges shall be painted with one coat of baked enamel primer, followed by one coat of baked enamel finish. The paint manufacturer's recommendations shall be followed in the application, drying time and temperature procedure for each coat. A low-temperature baking enamel and primer shall be used.

(2) Reflectorized Background. All edges shall be sealed using one coat of exterior aluminum paint followed by one coat of air-drying enamel with a color closely matching the color of the reflectorized background. The reflectorized sheeting shall be applied to the surface by an approved vacuum applicator or continuous roll applicator using a combination of heat and vacuum or pressure. The preparation of the plywood surface and the application process shall be in complete conformance with the recommendations of the manufacturer of the reflective sheeting used.

(C) Letters, Symbols and Accessories. The Bureau of Public Roads standard alphabets and spacing shall be used on all signs erected.

(1) Reflectorized, Removable Cutout Legend and Borders. These shall be applied to sign background with screws or rivets of the type recommended by the manufacturer of the cutout letters and borders.

(2) Screen Processed Legend and Borders. Legend and border on reflectorized backgrounds shall be screen processed or reversed screened. The recommendations of the manufacturer of the reflective sheeting shall be followed in the use of process paints.

(3) Permanently Adhered Reflectorized Legend and Borders. Legend and border shall be cut from reflectorized sheeting. Letters shall not be spliced. Application of letters shall be

in complete conformance with recommendations of the manufacturer of the reflective sheeting used.

88.04 CONSTRUCTION METHODS. All signs shall be located and erected as shown on the plans, except the engineer may change a sign location where necessary to secure an acceptable location. The engineer will establish all locations as shown on the plans or as he designates.

Signs shall normally be erected so the sign face is truly vertical and at the alignment with the oncoming traffic as shown on the plans.

After installation of signs is complete, they shall be inspected at night by the engineer. If specular reflection is apparent on any sign, its position shall be adjusted by the contractor to eliminate this condition.

Post, pole or foundation holes shall be augered or dug to the required size. In backfilling the holes for sign posts or poles, the contractor shall thoroughly mix with the material removed from the hole, Portland cement in the ratio of one part of cement to ten parts of the material from the hole and enough water to make a soil-cement mixture of optimum compaction. This mixture of backfill material shall be thoroughly compacted around the post or pole, using lifts of not more than 8 inches in thickness. The contractor may elect to use Class "F" concrete to backfill the hole with timber posts or poles. Foundation holes for steel sign posts shall be backfilled with Class "A" or "DD" concrete; the top 12 inches of concrete foundations shall be formed except when the foundation is to be finished flush with the ground, pavement, or sidewalk.

All welding of metal joints and breaks shall conform to Article 42.06(U).

88.05 METHOD OF MEASUREMENT. **(A) Aluminum Signs.** Aluminum sheet and aluminum extruded signs will be measured to the closest one tenth square foot of the sign face as accepted complete in place.

(B) Plywood Signs. These will be measured to the closest one tenth square foot of the sign face as accepted complete in place.

(C) Metal Posts. The poundage to be paid for shall be the number of pounds of metal in each post calculated from the nominal weight per foot times the length of each post, as shown on the plans, complete in place in the concrete footing and accepted. The poundage of tapered posts and posts of non-uniform section shall be paid for in accordance with invoice weights.

(D) Treated Timber Posts. Timber posts complete in place according to the plans and these specifications, will be measured separately by the thousand feet board measure. Measure-

ments will be computed from the dimensions shown on the plans. Accepted commercial timber sizes and lengths for each post will be used as basis of measurement.

(E) Treated Timber Poles. The length of treated timber poles for basis of payment will be the actual length of pole as indicated on the plans.

(F) Lump Sum. When a signing system is bid on a "lump sum" basis there will be no direct measurement unless specified otherwise.

88.06 BASIS OF PAYMENT. Highway signs and signing will be paid for at the contract bid price, which price and payment shall be full compensation for completing The Work in an acceptable manner. The prices bid for the various component parts shall include concrete for foundations, all miscellaneous hardware, equipment use and any other incidentals that may be required.

When a signing system is bid on a "lump sum" basis payment will be made accordingly.

SECTION 90 TRAFFIC GUIDANCE DEVICES

SUBSECTION 90.00 GUARD RAIL AND MEDIAN BARRIER RAIL.

90.01 DESCRIPTION. "Guard Rail and Median Barrier Rail" shall consist of the furnishing and installation of metal beam guard rail or median barrier rail, as stipulated in the proposal, in conformity with the plans, standard drawings and specifications or as directed.

90.02 MATERIALS. (A) Rail. (1) Vacant.

(2) Metal Beam and Fittings. (a) Steel Beam. Steel beam guard rail units and special bolts shall conform to AASHO M 180. Lengths of sections shall be such that splices will occur on posts spaced at 12.5 feet. Where the rail is to be erected on a curve of radius less than 150 feet, it shall be shaped before erection.

(b) Aluminum Beam. Aluminum beam guard rail units shall be Alclad 2024-T3 (ASTM B 209 alloy clad CG42A-T3). Bolts shall be alloy 2024-T4 (ASTM B 211 alloy CG42A-T4). Nuts shall be alloy 6061-T6 (ASTM B 211 alloy GS11A condition T6). Washers shall be alloy 2024-T4 (ASTM B 209 alloy clad CG42A condition T4). Rail units and hardware shall be neither galvanized nor painted. Fabrication shall conform to the same

requirements set forth in Part (a)—shape, holes, lengths, etc. Terminal sections shall conform to Alclad 2024-T42 sheet (ASTM B 209 alloy clad CG42A-T42).

The rail element shall conform to the following table. The post connection shall withstand a 5,000 pound side pull in either direction.

Nominal Thickness of Sheet Inches	Minimum Tensile Strength of Joint Lbs.	Beam Strength			
		Traffic Side Maximum Load—lbs.	Up Deflection Inch	Traffic Side Maximum Load—lbs.	Down Deflection Inch
	80,000	1,500	2.0	1,200	2.0
(1)		2,000	3.0	1,600	3.0

(1) Sections must be interchangeable with steel beam—AASHO M 180.

NOTE—Test shall be made with rail element freely supported on a 12 foot clear span and the load applied through a 3 inch flat surface at the center of the span.

Lengths of sections shall be such that splices will occur on posts spaced at 12.5 feet. Where the rail is to be erected on a curve of radius less than 150 feet, it shall be shaped before erection.

(B) Posts. (1) Wood. Shall be of Douglas Fir, Hemlock, Ponderosa Pine, Northern White Cedar, Western Red Cedar, Larch or Lodgepole Pine. Posts shall be straight, sound and free from defects of all kinds and they shall be cut from live trees not less than thirty days in advance of use, but not exceeding one year. The posts may be rough-sawed or surfaced at the contractor's option. Shapes and dimensions shall conform to current standard drawings. All bark shall be peeled and the logs trimmed smooth of all knots and projections.

Sawed posts shall meet the requirements for "Construction" grade posts and timbers as set forth in the rules of the West Coast Lumber Inspection Bureau, or other equivalent grading rules, all of which must conform to ASTM D 245.

Posts shall be so nearly straight that the surface shall not vary more than one inch from a straight edge connecting the ends. The posts shall be seasoned in such a manner and to such an extent that the remaining moisture content will not interfere with the prescribed treatment. Posts shall be treated with 5 percent pentachlorophenol, using heavy petroleum solvent, (0.40 lb. dry salts per cu. ft. of wood) and in accordance with Section 51. Treatment shall result in the darkest practicable color. The minimum depth of penetration shall be one-half inch. Such posts shall not be painted unless specified. When subjected to testing as a simple beam with a 24-inch span

and center loading applied to the back of the post, the posts shall withstand a load of not less than 30,000 pounds at failure.

Round posts for metal beam guard rail (and guide posts) shall conform to the following additional requirements:

(a) Splits. Permitted only on bottom end of post and no longer than post diameter.

(b) Peeling. All outer bark and at least 80% of inner bark shall be removed. The remaining inner bark shall be evenly distributed over the post surface and no strip shall be more than one-half inch in width.

(c) Size. The minimum post diameter shall be between eight and nine and one-half inches (8"-9½"). The top or small end shall be trimmed, a hole bored for a guard rail bolt and the larger or bottom end sawed off square in conformance with the applicable standard drawing. To enable the use of standard bolts for a seven and one-half (net) inch post, the post shall be slab gained (flattened) by machines on the back side, if necessary, from top of posts to a line two inches below the bolt hole, but the process shall not make the thickness at the bolt hole less than seven and one-half inches.

(2) Concrete Posts. Shall be precast and shall conform to the design and requirements stipulated in the proposal and/or shown on the plans. Concrete shall be Class "DD" and shall conform to Section 46. Reinforcing steel shall conform to Section 47. Size and shape shall conform to Standard Drawings.

(3) Steel Posts. Shall meet the requirements stipulated in the proposal or shown on the plans or standard drawings.

(C) General. (1) Wood Treatment. All posts shall be pressure treated with pentachlorophenol in accordance with Section 51. Chamfering and other required framing and boring of bolt holes shall be performed prior to treating the material. Holes made for determination of penetration of preservative shall be plugged with tight fitting treated wood plugs.

(2) Painting. When specified, paint and painting shall meet the requirements of Article 54.06(E) and (B) (4).

90.03 CONSTRUCTION METHODS. (A) Posts. Except for certain types of steel posts which may be set by driving, all posts shall set in holes dug or augered in the ground and firmly tamped in place to the line and grade established by the engineer. Backfill material shall be placed around the posts, in layers not to exceed three inches loose depth and thoroughly tamped, using water to aid compaction when required, by hand or acceptable machine methods.

Posts and rail shall be so shaped and set that positive and firm contact will result between rail and posts. Detailed requirements for installation and erection of all types of guard

rail and barrier rail will be stipulated in the proposal or shown on the plans or current standard drawings.

(B) Vacant.

(C) Metal Beam. The rail unit shall be spliced by lapping in the direction of traffic. All splices must be made at a post. The rails at the splice shall make contact throughout the area of splice.

Median barrier rail shall be constructed in accordance with applicable standard drawings. Median barrier rail is composed of the same specified elements which comprise beam guard rail, except that there is a railing on each side of the post, presenting a barrier toward each roadway. The terminal section shall be specially designed for the purpose. Materials shall conform to Article 90.02. A galvanized metal or aluminum alloy washer, shaped to reasonably conform with the form of the metal railing, shall be used under the nut which goes on the threaded end of the bolt which holds the rail to the post. The type of rail and post shall be as specified.

Bolts through joints and mounting bolts shall be drawn up as tight as possible without being tight enough to prevent the rail elements from sliding past one another longitudinally. Bolts shall be sufficiently long to extend to at least one-quarter inch beyond nuts. Except where required for adjustments, bolts shall not extend more than one-half inch beyond the nuts.

After erection, all abrasions on metal parts shall be spot painted with first field coat of paint before final application of aluminum paint. The finished sections in place and completed shall be free from bruised, broken, scaled or otherwise damaged spelter.

90.04 METHOD OF MEASUREMENT. Guard rail and median barrier rail will be measured to the nearest one tenth lineal foot, along the face of the completed rail, from center to center of the end posts of each section. The length of median rail shall include the rail on both sides. The terminal sections of beam guard rail will not be measured as such but shall be considered as necessary accessories, unless provided otherwise in special cases.

90.05 BASIS OF PAYMENT. Guard rail and median barrier rail will be paid for at the contract unit bid price, which price and payment shall be full compensation for The Work.

SUBSECTION 90.40 GUIDE POSTS.

90.40 DESCRIPTION. "Guide Posts" shall consist of the furnishing and installation of various types of guide posts and accessories as stipulated in the proposal form, in conformity with the plans and specifications or as directed.

90.41 MATERIALS. **(A) Wood Posts.** Wood posts shall conform to the applicable provisions of Article 90.02 (B) (1) and

(C) (1). Size and form shall conform to applicable Standard Drawings.

(B) **Concrete Posts.** These shall conform to Article 90.02 (B) (2) and Standard Drawings.

(C) **Steel Posts—Type 1.** Type 1 steel posts shall conform to Article 88.02, Part (D) (1) and Part (D) (2) (b). All posts shall be galvanized.

(D) **Metal Posts—Type 2.** These posts shall be a good commercial quality of iron or steel. They shall be standard T, I, U or L with a minimum weight of 1.33 lbs. per foot. Posts shall be galvanized in accordance with ASTM A 123. An anchor plate will not be required. See Standard Drawing.

(E) **Corrugated Metal Posts—Type "A" and "B".** See Standard Drawing. The corrugated metal shall be Gage 16, of size and shape shown on the drawing. The base metal and galvanizing shall conform to AASHO M 36; galvanizing shall be done after cutting and after the backing plates have been welded in place. The metal U post used with Type "B" shall conform to Part (C) above as well as the drawing.

(F) **Backplate or Faceplate.** For posts and delineators. Any backplates or faceplates that may be required shall conform to standard drawings or plans.

(G) **Delineators.** (1) **Acrylic Plastic Reflectors.** (a) **Description.** The reflector shall consist of a hermetically sealed acrylic plastic prismatic reflex reflector housed in embossed aluminum and provided with a single grommetted mounting hole.

(b) **Design and Fabrication of Metal Parts.** Housing shall be 0.020" 5052-H 32 aluminum formed to approximately 3.25" in diameter and 0.235" in depth to retain the acrylic reflector. Housing shall be provided with four embossed circular reinforcement ribs and marked with name and part number of manufacturer. An aluminum grommet with a 3/16" inside diameter shall be expanded within the reflector mounting hole.

(c) **Acrylic Plastic Reflector.** The reflector shall be acrylic plastic and the bidder will specify the manufacturer of the raw material and the identification number of the particular molding compound to be furnished. Acceptable formulations are:

Manufacturer	Trade Name	Type of Molding Compound
E. I. duPont deNemours & Co. Inc.	Lucite	HM-140
Rohn and Haas Co.	Plexiglas	V

The reflector shall consist of a clear and transparent plastic face, with 7 square inches of reflective area, herein referred to as the lens, with a heat sealable plastic coated metallic foil back fused to the lens under heat and pressure around the entire circumference of the lens and the central mounting hole to form a unit permanently sealed against dust, water, and water vapor. The reflector shall be colorless, or yellow.

The lens shall consist of a smooth front surface free from projection or identification other than a central mounting hole and identification with a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light. The manufacturer's trade mark shall be molded legibly into the face of the lens.

(d) Optical Requirements. **(1) Definitions.** "Entrance Angle" shall mean the angle at reflector between direction of light incident on it and direction of reflector axis. "Observation Angle" shall mean the angle at reflector between observer's line of sight and direction of light incident on reflector. "Specific Intensity" shall mean candlepower returned at the chosen observation angle by a reflector for each foot-candlepower returned at the chosen observation angle by a reflector for each foot-candle of illumination at the reflector.

(2) Specific Intensity. The specific intensity of each reflex reflector intended for use in delineators or markers shall be equal to or exceed the following minimum values regardless of reflector orientation. Failure to meet the specific intensity minimum shall constitute failure of the reflector being tested; failure of more than 2 reflectors out of 50 subjected to test shall constitute failure of the lot.

Observation Angle Minutes	Entrance Angle Degrees	Specific Intensity	
		Candlepower per foot-candle Crystal	Yellow
6	0°	60	36
6	20°	24	15
20	0°	20	12
20	20°	8	5

(e) Requirements. Optical testing procedure, durability, seal test, heat resistance test, sampling procedure and packaging shall conform, as nearly as practicable, to like requirements set forth in Article 88.02, Part (K) (2) (d).

(2) Reflective Sheeting Reflectors. **(a) Description.** The silver-white and yellow delineators shall be of adhesive coated reflective sheeting permanently adhered to a sheet aluminum backing. The reflective sheeting shall consist of spherical lens elements embedded within a transparent plastic having a smooth, flat outer surface.

Silver-white delineators shall be 3" x 8" rectangles with $\frac{3}{4}$ " radius corners and two $\frac{1}{4}$ " diameter mounting holes, 6" on center.

Yellow (amber) delineators shall be 5" x 5" diamonds with $\frac{3}{4}$ " radius corners and $\frac{1}{4}$ " diameter holes for center mounting.

(b) Photometric Requirements. Each reflective delineator shall have the following minimum brightness values at 2° divergence expressed as candlepower per foot candle. Measurements shall be conducted in accordance with standard photometric testing procedures for reflex reflectors of the Society of Automotive Engineers.

Angle of Incidence	Silver-White		Yellow	
Divergence Angle	.2	.5	.2	.5
0°	9.0	3.8	5.3	2.3
15°	8.0	3.4	4.4	2.0
30°	5.4	2.9	2.7	1.2
45°	2.6	1.1	1.0	0.5

The brightness of the reflective sheeting, totally wet by rain, shall not be less than 90% of the above values. Wet performance measurements shall be conducted in conformance with standard rainfall tests specified in Military Specification MIL-R-13689A, or as amended.

(c) Color. Color requirements shall conform to Article 88.02, Part (J) (3), silver-white and yellow.

(d) Adhesive. The reflective sheeting shall be pre-coated with a tack free adhesive which will adhere to the aluminum backing only when activated by heat or solvent. The sheeting shall adhere securely at temperatures of -30° to 200°F. and shall be elastic enough at low temperatures to resist shocking off when struck at -10°F. without appreciable decrease in adhesion, and vandal resistant and strong enough to resist peeling from the applied surface. The pre-coated adhesive shall have no staining effect on the reflective sheeting and must be mildew resistant.

(e) Durability. Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and following cleaning shall show no appreciable discoloration, cracking, crazing, blistering, or dimensional change and not less than 80% of the specified minimum brightness values when exposed to accelerated weathering for either 175,000 Langleys (approximately one year), south facing, unprotected at 45° in south Florida; or 1,200 hours Atlas Twin arc weathering in accordance with ASTM D 822.

The delineator surface may be readily refurbished by cleaning and clear overcoating in accordance with the manufacturer's recommendations.

(f) Fabrication. The reflective sheeting shall be mechanically applied with the equipment and in a manner prescribed by the sheeting manufacturer.

The aluminum shall be 6061 T6 alloy .040" thick sheet properly degreased and etched or treated with a light, tight amorphous chromate type coating. Completed delineators shall be dip coated with a full glossy coat of finishing clear as specified and supplied by the sheeting manufacturer.

(g) General Requirements and Packaging.

The finished delineators shall show careful workmanship and be clean-cut, sharp and have essentially a plane surface.

The manufacturer shall certify that all delineators furnished conform to this specification and will replace or repair without cost all delineators which fail to meet these requirements.

Delineators shall be packaged in such a manner as to insure their arrival at destination in undamaged condition. Delineators shall not become wet in storage or shipment.

(H) Bolts and Nuts or Studs. Bolts and nuts, or studs, which fasten the backplate to the post shall be either cadmium plated or galvanized in accordance with ASTM A 153. The nut or stud shall be of "vandal resistant" design satisfactory to the engineer. Other miscellaneous hardware shall be galvanized in accordance with ASTM A 153.

90.42 CONSTRUCTION METHODS. **(A)** Wood guide posts shall be installed in accordance with Article 90.03, the plans and as directed.

(B) Metal posts, when driven into the ground, shall be well protected to guard against damage. Damaged posts shall be repaired or replaced. The post shall be firmly set in the ground and within two degrees of plumb. When holes are dug the posts shall be firmly tamped into position. Locations shall be as shown on plans or as directed.

90.43 METHODS OF MEASUREMENT. All types and kinds of guide posts shall be measured by the number installed and accepted.

90.44 BASIS OF PAYMENT. All types of guide posts, including any accessories placed thereon, shall be paid for at the unit price bid, which price and payment shall be full compensation for The Work.

SUBSECTION 90.70 JIGGLE BARS & TRAFFIC BUTTONS.

90.71 DESCRIPTION. Jiggle Bars and Buttons shall consist of traffic guidance devices prepared and constructed in accordance with the specifications, plans and standard drawings and placed where designated by the plans or engineer.

90.71 MATERIALS. **(A) Type 1 Jiggle Bars.** The aggregate and bitumen shall conform to Article 74.02 as it pertains to bituminous curb. The design shall conform to applicable standard drawings.

(B) Traffic Button. Traffic buttons shall be formed from gray cast iron or similar material. The anchor pin shall be made from a mild steel or similar metal. The design shall conform to applicable standard drawing.

90.72 CONSTRUCTION METHODS. **(A) Type 1 Jiggle Bars.** Construction methods shall conform to Article 74.03 for bituminous curb except as modified herein. The jiggle bars shall be placed either on the bituminous mat or concrete pavement. Installation on top of an applied seal coat will not be permitted unless absolutely all loose cover aggregate has been removed from the surface to assure a tight bond. Diluted SS-1 emulsified asphalt, at the approximate rate of 0.1 gal./sq. yd., on the base, shall be used as adhesive or tack coat between the surface and the jiggle bar. Placement by hand forming and tamping will be permitted if the end result is satisfactory to the engineer. The jiggle bars must be cast-in-place—not elsewhere and moved onto the site. The finished product shall be tightly compacted with a smooth surface. Location, shape and size shall conform to standard drawings.

(B) Traffic Button. Traffic buttons shall be installed, where designated, on a clean surface. Each button shall be securely pinned to the surface by the anchor pin.

90.73 METHOD OF MEASUREMENT. Jiggle bars shall be measured, to the nearest half-foot, from end to end of bar. Traffic buttons will be measured per each.

90.74 BASIS OF PAYMENT. Payment for jiggle bars will be made on the lineal foot basis. Payment for traffic buttons will be per each. Payment will be full compensation for furnishing all labor, materials, adhesive, tools and equipment involved in furnishing a completed acceptable product.

SECTION 91

MARKERS AND MONUMENTS

91.01 DESCRIPTION. "Markers and Monuments" shall consist of the furnishing and erection of project markers, station markers, right-of-way monuments and such other markers as may be specified, conforming to the requirements of the plans and specifications, at the locations shown on the plans or as directed.

91.02 MATERIAL. Markers and monuments shall be constructed of the material and in the manner required by the plans and standard drawings. Concrete and reinforcing steel shall conform to Section 46, and Section 47, as specified in the pertinent standard drawings.

91.03 CONSTRUCTION METHODS. All markers and monuments shall be set in the ground at the exact locations designated by the engineer. They shall be thoroughly tamped into place with care being taken to prevent shifting of position during the course of backfilling and tamping. Reference is here made to the pertinent standard drawing.

Project markers shall be set three feet in the ground opposite the beginning and end of projects.

Station markers shall be, unless otherwise directed, set normal to the centerline, at the station shown on the marker, with the face of the marker furthest from the roadway, one foot inside the right-of-way line.

Right-of-way monuments, in general, shall be set in such manner that the face of the monument furthest from centerline will coincide with the right-of-way line.

91.04 METHOD OF MEASUREMENT. Markers and monuments will be measured by the number of each type used in the completed and accepted work.

91.05 BASIS OF PAYMENT. Markers and monuments will be paid for at the contract unit bid price for the number of each type, complete and accepted in place, which price and payment shall be full compensation for The Work.

SECTION 92

ADJUST EXISTING STRUCTURES

92.01 DESCRIPTION. "Adjust Existing Structures" shall consist of the adjustment, to required line and grade, of manholes, catch basins, inlets, water valve boxes and such other utility structures, not privately owned, as may be shown on the plans or encountered in The Work.

92.02 MATERIAL. All material such as concrete, brick and mortar shall meet specifications as noted in the section concerning the particular material involved, or if the material is not covered in these specifications, the material used for adjusting shall be equal, and comparable to that in the existing structure. If extensions for water valve boxes are required, they shall be comparable to the valve boxes found to exist. Close cooperation shall be maintained with the owner of each facility concerning material proposed to be used.

92.03 CONSTRUCTION METHODS. All existing manholes, catch basins, inlets, water valve boxes, gas and water shut-offs and all other structures of this kind shall be adjusted to grade by either lowering or raising as required or in accordance with the details shown on the plans. Care shall be used in removing portions of the top of the manholes if the cover must be lowered so as not to damage the lower part of the manhole. Before the ring and cover is replaced, the top of the masonry on the manhole must be prepared true to line and grade.

Water valve boxes must be excavated and exposed so as to readily determine whether height adjustment can be made without the use of an extension.

Manholes, catch basins, inlets, water valve boxes and other structures of this kind shall be adjusted to temporary grade before base course material is placed in order to allow the structure to be covered and paving carried over the top. After paving is completed and before seal coat is applied the paving shall be neatly cut to the area required and removed so that the final adjustment can be made to coincide with the grade of the new pavement. Backfilling shall then be placed and compacted around the structure and new paving material of the required thickness placed to complete and evenly fill the area between the cover and the pavement. Manholes may be covered with planking or other substantial material before the pavement is placed. The cast iron ring and cover shall be replaced and set to proper grade after the pavement is in place.

Backfilling around any structures shall be done in accordance with Section 75.

92.04 METHOD OF MEASUREMENT. Measurement will be made on the basis of each of the various types of structures required to be adjusted, completed and accepted.

92.05 BASIS OF PAYMENT. "Adjust Existing Structures" will be paid for at the contract unit bid price, which price and payment shall be full compensation for The Work.

SECTION 93

REMOVE AND RESET FACILITIES

93.01 DESCRIPTION. "Remove and Reset Facilities" shall consist of removing, from an existing installation, storing, and resetting such facilities and objects as shall be designated by the proposal in accordance with the specifications, the plans and special provisions or as directed by the engineer.

93.02 MATERIALS. Any materials that may be necessary in removing and resetting the prescribed facility shall conform, as nearly as practicable, to the materials of which said facility is constructed. If substitution is necessary, the approval of the engineer shall be obtained. If and when the facility, being moved and reset is covered by this book of specifications then materials, construction methods and other pertinent provisions of the applicable section shall apply.

93.03 CONSTRUCTION METHODS. Facilities designated to be removed and reset shall be removed with utmost care and diligence with all efforts directed toward maintaining the existing condition of the facility. It shall be carefully handled, stored with care if necessary and reset when and where directed by the engineer. The contractor shall be responsible for the condition and care of the facility from the time removal starts until resetting is completed, unless the engineer determines that such a provision is impracticable.

When this specification is inadequate to cover all essentials involved in the work contemplated, a special provision shall be prepared and it shall govern.

93.04 METHOD OF MEASUREMENT. Measurement shall be made as indicated by the proposal and the description of the item.

93.05 BASIS OF PAYMENT. Payment shall be made in accordance with the bid price in the proposal form which price shall be full compensation for The Work. The item description for "remove and reset", when listed in the proposal form, will be abbreviated to "reset".

SECTION 94

MISCELLANEOUS ITEMS

94.01 MISCELLANEOUS ITEMS. This section is to be used for administrative and accounting purposes. It is not a specification prescribing the use of certain materials nor specifying how work shall be done.

The purpose of this section is to establish item numbers for furnishing of certain materials and/or performing certain work that does not fall within the scope of other sections of this book of specifications.

SECTION 95

REMOVAL OF EXISTING STRUCTURES AND MISCELLANEOUS FACILITIES

SUBSECTION 95.10 REMOVAL OF EXISTING STRUCTURES.

95.11 DESCRIPTION. "Removal of Existing Structures" shall consist of the removal and satisfactory disposal of all portions of existing structures except such portions as may be required or permitted to be left in place by the specifications, the plans, or the special provisions, and also the maintenance of traffic and all other operations specified in this section. This subsection shall generally concern bridges and similar structures. The term "maintain traffic" refers to traffic on highways.

95.12 REMOVAL OF SUPERSTRUCTURES. Portions of steel or timber superstructures required to be salvaged shall be dismantled, handled and stored in such manner as to avoid any unnecessary damage to any member thereof. Any and all members, pins, nuts, plates, etc., which are damaged, cut or destroyed as a result of the contractor's operations, shall be repaired or replaced by the contractor at his sole expense. Concrete and masonry superstructures shall be removed and disposed of as provided herein unless otherwise specified.

All members shall be match-marked with paint before they are dismantled. All pins, nuts, plates, etc., shall be similarly marked to indicate their proper location; all pins, pin holes, and machined surfaces shall be painted with a mixture of

white lead and tallow, and all loose parts shall be wired to adjacent members or packed in boxes with contents clearly marked thereon or index numbered for future identification.

95.13 REMOVAL OF SUBSTRUCTURES. Unless otherwise specified or ordered by the engineer, all portions of the substructures of existing structures above the bed of the stream, finished ground surface, or ground surface as it existed before the work was started, and all portions below the bed of the stream or ground surface which interfere in any way with the new construction, shall be removed. Blasting or other operations which might endanger the new work shall be completed prior to the construction of any part of the new structure.

Where piles compose the substructure, or a part thereof, the contractor shall cut off the piles one foot below the finished ground surface, or pull them, as he prefers. However, if they interfere with the new construction, he shall remove them completely.

The substructures for temporary bridges shall be removed as required herein for the substructures of existing structures.

95.14 DISPOSAL OF MATERIALS REMOVED. (A) **Structural Steel.** Structural steel members removed from the old structures shall, unless otherwise specified or directed, be stored in a neat and presentable manner in designated locations within the right-of-way and adjacent to the site of The Work. Members of structures which are to be re-erected and all steel beams shall be stored above the ground surface on skids or otherwise protected as directed.

(B) **Concrete and Masonry.** Concrete and masonry which is removed from old structures shall, as far as practicable, be placed in backfills or approach embankments or shall be used to riprap the slopes of the embankments or the channel if specified on the plans. Any concrete or masonry which cannot be placed in backfills or embankments or used as riprap shall be disposed of as directed and in such manner as to prevent damage to property or the creation of unsightly conditions.

(C) **Timber and Other Materials.** All timber and other materials having salvage value shall be piled up in a neat and presentable manner on skids above ground in designated locations, within the right-of-way and adjacent to the site of The Work.

(D) **Ownership of Materials Removed.** All materials having salvage value shall be disposed of as provided herein and shall be considered the property of the State. Written permission to use any of these materials in the contractor's operations shall be secured from the engineer.

95.15 DISPOSAL OF TEMPORARY STRUCTURES, CLEANING SITES, ETC. Upon the completion of the new structures, with the necessary backfilling and roadway embankments, the

contractor shall remove and dispose of any temporary structure he may have installed in connection with the maintenance of traffic, to the satisfaction of the engineer; and furthermore, he shall leave the adjacent premises in such condition as to present neat and acceptable appearances.

95.16 BASIS OF PAYMENT. If the contract contains a separate item and price for "Removing Existing Structures and Maintaining Traffic," such lump sum price shall be payment in full for the removal and disposal of the existing structures, maintenance of traffic, and all other operations specified in this subsection.

If the contract does not contain a separate item and price for "Removing Existing Structures and Maintaining Traffic," payment in full for the work specified in this subsection shall be considered as included in the contract unit prices for the various items of the contract.

The item description used in proposal and estimates will be abbreviated by deletion of the word "existing"; e.g. "Remove Structure"

SUBSECTION 95.20 REMOVAL OF MISCELLANEOUS FACILITIES.

95.21 DESCRIPTION. "Removal of Miscellaneous Facilities" shall consist of the removal and disposal of miscellaneous existing facilities which are listed in the proposal form, such as curb, gutter, curb and gutter, fireplug, manhole, inlet, sidewalk, driveway, headwall, box culvert, sign, etc., in accordance with this specification, the plans and special provisions. This subsection will not pertain to any such facilities that will be reset or reinstalled under the contract.

95.22 REMOVAL OF FACILITY. The facility will be removed from the Highway or area of construction in as neat and workmanlike manner as is practicable. Any and all facilities, belonging to a person or persons, that can be or are to be used and reinstalled elsewhere shall be removed carefully and without damage, if possible, and placed where directed by the engineer. Facilities that must be wrecked or damaged in removal shall be disposed of in a place away from the Project and the contractor shall be responsible for such disposition.

If and when these specifications are inadequate, under the circumstances, a special provision or supplemental specification will be prepared and shall apply.

95.23 METHOD OF MEASUREMENT. Measurement shall be as indicated in the proposal form; by the item number; or as prescribed by the special provisions.

95.24 BASIS OF PAYMENT. When the contract contains a separate item and price for removal of facilities, listed in the proposal, such price shall be full payment for The Work specified or indicated by the provisions of this subsection.

SECTION 97

NON-PARTICIPATING ITEMS

97.01 DESCRIPTION. This section shall concern work and materials not eligible for Federal Aid and materials that are stockpiled for use by the Department and in which there is no Federal Aid participation in the cost of the material as placed in the stockpile. Some such material may be incorporated in a later contract on a participating basis—e.g., cover material.

97.02 MATERIAL. The material shall conform to the provisions of the particular section of these specifications which concerns the material specified in the proposal, or as may be set forth in special provisions.

97.03 CONSTRUCTION AND PRODUCTION METHODS. These methods shall conform to the provisions of the particular section of these specifications which concerns the material specified in the proposal, or as may be set forth in special provisions. Stockpile construction shall conform to the provisions of Section 28.

97.04 METHOD OF MEASUREMENT. Measurement shall conform to the methods specified in the section of these specifications which concerns the material specified in the proposal, or as may be set forth in special provisions.

Haul of any of the materials shall be in accordance with the applicable provisions of Section 13, if such item is in the proposal.

97.05 BASIS OF PAYMENT. Payment shall be in accordance with the provisions of the section of these specifications which concern the material specified in the proposal, or as may be set forth in special provisions. Haul shall be paid for as specified in Section 13, if such item is in the proposal.

ADDENDA

NOTE: The following contract form and contract bond form are subject to change during the course of effectiveness of this book. This copy may not exactly conform to the contract form to be executed by the contractor and he must be guided accordingly.

STATE OF MONTANA

State Highway Commission

CONTRACT

WITH

Address _____

FOR
CONSTRUCTION OF

County, Montana

Project No. _____

Date of Execution _____

Work Begun _____

Work Finished _____

CONTRACT FORM

(This form when contractor is corporation.)

This Agreement, made and entered into, in duplicate, this
day of _____, 19_____,
by and between the State of Montana, acting by and through
The State Highway Commission, hereinafter called the State,
and _____, incorporated
under the laws of its successors and assigns, hereinafter called
the contractor.

Witnesseth, That the contractor, for and in consideration of
the payment herein specified and agreed to by the State, to be
paid said contractor, hereby covenants and agrees to furnish
and deliver and pay for all of the materials and to furnish all
tools, machinery and implements, and to do and perform all the
work and labor in the construction or improvement of a certain

highway/bridge _____ in _____ County,

State of Montana, _____ Project No. _____
according to the dimensions and grades thereof this day agreed
upon between the parties hereto and shown and stated in the
plans, standard specifications, supplemental specifications and
special provisions, said construction and improvement being
approximately (_____) miles in length, at the unit
prices bid by the said contractor for the respective estimated
quantities, aggregating approximately the sum of _____

Dollars (\$ _____)

and such other items as are mentioned in _____
original proposal, which proposal, and prices named, together
with the standard specifications which are not hereto annexed
because of their volume, but which are by this reference in-
corporated into and made a part of this contract, and together
with supplemental specifications and special provisions, copies
of which are attached hereto and made a part of this contract.

The contractor, for and in consideration of the payment
herein specified and agreed to by the State, further agrees and
covenants that all of said work and labor upon said construc-
tion and improvement shall be performed in strict compliance
with the plans of the said construction or improvement pre-
pared by The State Highway Commission, hereinafter referred
to as The Commission, which said plans also by this reference
are incorporated into and made a part of this contract.

The said improvement is described and situated as follows:

CONTRACT FORM

(This form when contractor is individual or copartnership).

This Agreement, made and entered into, in duplicate, this _____ day of _____, 19_____, by and between the State of Montana, acting by and through The State Highway Commission, hereinafter called the State, and _____ his, her, or their heirs, executors, administrators and assigns, hereinafter called the contractor.

Witnesseth, That the contractor, for and in consideration of the payment herein specified and agreed to by the State, to be paid said contractor, hereby covenants and agrees to furnish and deliver and pay for all of the materials and to furnish all tools, machinery and implements, and to do and perform all the work and labor in the construction or improvement of a certain highway/bridge _____ in _____ County,

State of Montana, _____ Project No. _____ according to the dimensions and grades thereof this day agreed upon between the parties hereto and shown and stated in the plans, standard specifications, supplemental specifications and special provisions, said construction and improvement being approximately (_____) miles in length, at the unit prices bid by the said contractor for the respective estimated quantities, aggregating approximately the sum of _____

Dollars (\$ _____)

and such other items as are mentioned in original proposal, which proposal, and prices named, together with the standard specifications which are not hereto annexed because of their volume, but which are by this reference incorporated into and made a part of this contract, and together with supplemental specifications and special provisions, copies of which are attached hereto and made a part of this contract.

The contractor, for and in consideration of the payment herein specified and agreed to by the State, further agrees and covenants that all of said work and labor upon said construction and improvement shall be performed in strict compliance with the plans of the said construction or improvement prepared by The State Highway Commission, hereinafter referred to as The Commission, which said plans also by this reference are incorporated into and made a part of this contract.

The said improvement is described and situated as follows:

CONTRACT FORM

(The following applies to both types of contract.)

It is understood and agreed, by and between the parties hereto, that the term "Standard Specifications" as hereinabove used, refers to the standard specifications for road and bridge construction, _____ Edition.

It is further understood and agreed that said construction and work shall be done in strict compliance with said standard specifications and further, it is expressly understood and agreed that no rules, customs or usages, either local or otherwise, shall in any way be considered, implied, or inferred into this contract. It is also understood and agreed that it shall be the sole responsibility of the contractor to obtain said standard specifications which may be obtained from the State Highway Department Building at Helena, Montana.

The contractor further covenants and agrees that he will, except as herein provided, begin the actual performance of the work required and contemplated under this contract, in accordance with the provisions set forth in the standard specifications, and that all and every of the said materials shall be furnished and delivered and all and every of the said labor shall be done and performed in every respect to the satisfaction and approval of the engineer (a) on or before (date) _____ or (b)

within _____ calendar days. It is expressly understood and agreed that, in case of failure on the part of the contractor, for any reason, except with the written consent of the State to complete the furnishing and delivery of the said material and the doing and performance of said work within the specified time, the State shall have the right to deduct from any moneys due the contractor, or if no moneys shall be due,

the State shall have the right to recover the amount of _____

_____ Dollars (\$ _____), per day, as fixed, agreed and liquidated damages, and not as a penalty, for each and every calendar day elapsing between the date above stipulated for completion and the actual date of completion and final acceptance; this in accordance with the paragraph of the standard specifications, which refers to "Failure to Complete the Contract on Time".

In case any claim or dispute arises between the parties hereto, respecting any matter pertaining to this agreement, or any part thereof, said claim or dispute shall be referred to The Commission by the contractor, in writing, and a request for a hearing within a period of sixty (60) days after the claim or dispute has arisen, and, upon request, The Commission shall afford the contractor an opportunity for a hearing as early as practicable within not to exceed thirty (30) days after receipt of such request, in the County of Lewis and Clark, State of Montana, unless The Commission and the contractor agree that such hearing may be held in some other county. Upon such

CONTRACT FORM

hearing, The Commission shall be the authority to hear said claim or dispute and render a decision and appropriate order.

The contractor shall have the right to appeal to any District Court of the State of Montana within one year after a final decision has been rendered pursuant to the settlement procedure hereinabove contained.

The contractor further agrees that he will save and keep harmless the said State of Montana against and from all losses to it from any cause whatever, including patent, trademark and copyright infringements in the manner of constructing such section of roadway.

The contractor hereby further agrees to receive the prices set forth herein, and in the various instruments which are incorporated hereinto, as full compensation for furnishing all of the materials and labor which may be required in the prosecution and completion of the whole of the work to be done under this contract or agreement, together with its incorporated exhibits, and in all respects, to complete said contract to the satisfaction of the State.

There are attached hereto the instruction to bidders, the proposal form, certain special provisions and/or supplemental specifications and other pertinent instruments marked Exhibits

_____ to _____, all of which are concerned with and are by this reference incorporated into and made a part of this contract.

It is expressly understood and agreed between the parties hereto that, as a condition precedent to the complete execution of this contract, the contractor will furnish a good and sufficient surety bond to the State of Montana, in the amount of

_____ Dollars (\$_____), to be conditioned upon the faithful performance of the covenants and agreements as herein set forth by him to be performed, subject to the approval of the State.

(Incorporated firms sign below).

In Witness Whereof, the Chairman of The State Highway Commission, by authority in him vested, has hereunto subscribed his name on behalf of the State of Montana and affixed the seal of The State Highway Commission hereto, and the said

_____ has hereto attached its corporate seal duly attested by the signature of its duly authorized officers, the day and year above written.

CONTRACT FORM

STATE OF MONTANA
THE STATE HIGHWAY COMMISSION

By _____

Chairman

Contractor

By _____

President

Attest:

Commission Secretary

Attest:

Secretary

Approved as to form and legality.

Attorney

(Individual contractors or copartnership firms sign below).

In Witness Whereof, the Chairman of The State Highway Commission, by authority in him vested, has hereunto subscribed his name on behalf of the State of Montana, and affixed the seal of The State Highway Commission hereto, and the said

hereunto set _____ hand

and seal _____ the day and year above written.

STATE OF MONTANA
THE STATE HIGHWAY COMMISSION

By _____

Chairman

(SEAL)

Contractor

(SEAL)

By _____

Attest:

Commission Secretary

Witnesses:

Approved as to form and legality.

Attorney

CONTRACT BOND

KNOW ALL MEN BY THESE PRESENTS, That We,

hereinafter called the "Principal" and _____

_____, a corporation licensed under the laws of the State of Montana, hereafter called the "Surety", are held and firmly bound unto the State of Montana in the full and just sum of _____ Dollars (\$_____) lawful money of the United States of America, to be paid to the State of Montana, or its assigns, to which payment well and truly to be made and done, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

Sealed with our respective seals and dated this day of _____, 19_____.

WHEREAS, the above bounden "Principal" has entered into a contract with the State of Montana by The State Highway Commission, through its Chairman, bearing even date herewith, for the construction or improvement of a certain section of highway/bridge _____ / _____ in _____

County, State of Montana,

Project No. _____ being approximately _____ (_____) miles in length for approximately the sum of _____ Dollars (\$ _____) the said highway/bridge _____ / _____ being described and situated as follows:

and,

WHEREAS, It was one of the conditions of the award of The State Highway Commission, acting for and on behalf of the State of Montana, pursuant to which said contract was entered into, that these presents should be executed;

BOND FORM

NOW, THEREFORE, The condition of this obligation is such that if the above bonded "Principal" as contractor shall in all respects faithfully perform all of the provisions of said contract, and his, their or its obligations thereunder including the specifications therein referred to and made part thereof and such alterations as may be made in said specifications as therein provided for, and shall well and truly, and in a manner satisfactory to The State Highway Commission, complete the work contracted for, and shall save harmless the State of Montana, from any expense incurred through the failure of said contractor to complete the work as specified, or from any damages growing out of the carelessness of said contractor or his, their or its servants, or from any liability for payment of wages, due or material furnished said contractor and shall well and truly pay all laborers, mechanics, subcontractors and material men who perform work or furnish material under said contract, and all persons who shall supply him or the subcontractor with provisions, provender and supplies for the carrying on of the work, and also shall save and keep harmless the said State of Montana against and from all losses to it from any cause whatever, including patent, trademarks and copyright infringements, in the manner of constructing said section of work, then this obligation to be void or otherwise to be and remain in full force and virtue.

Signatures and Seals:

Surety Company

By _____

Attorney-in-Fact

Approved as to Form and Legality:—

Attorney

Witnesses:

Attest:

(SEAL)

APPROVAL OF STATE AUDITOR

ITEM NUMBERS AND DESCRIPTIONS

The following item numbers and descriptions pertain to the work covered by the contract and its various provisions. The first two digits of an item number, for the most part, are coincident with the section number of the specifications dealing with the particular item. The item number and descriptions listed herein are not, essentially, a part of the contract but will be used therein as occasion demands. These numbers are subject to change, modification, deletion or addition at any time. The numbers and descriptions used in the proposal will prevail.

1001	Clearing	Acre
1002	Clearing	Lump Sum
1011	Grubbing	Acre
1012	Grubbing	Lump Sum
1021	Clearing and Grubbing	Acre
1022	Clearing and Grubbing	Lump Sum
1031	Roadside Cleanup	Acre
1032	Roadside Cleanup	Lump Sum
1033	Roadside Cleanup	Square Yard
1101	Unclassified Excavation	Cubic Yard
1102	Street Excavation	Cubic Yard
1103	Trench Excavation	Cubic Yard
1104	Unclassified Borrow Excavation	Cubic Yard
1105	Unclassified Channel Excavation	Cubic Yard
1109	Unclassified Excavation	Cubic Yard

Item No. 1101 will be used on road construction projects, in general. Item No. 1109 will be used when the unclassified excavation is incidental to a project which is primarily for bridge or structure construction.

1151	Special Borrow Excavation	Cubic Yard
1161	Culvert Excavation	Cubic Yard
1162	Riprap Excavation	Cubic Yard
1163	Masonry Excavation	Cubic Yard
1164	Retaining Wall Excavation	Cubic Yard
1181	Subgrade Compaction	Cubic Yard
1201	Overhaul Unclassified Excavation	Station Yard
1202	Overhaul Unclassified Excavation	Mile Yard
1210	Overhaul Street Excavation	Station Yard
1211	Overhaul Street Excavation	Mile Yard
1212	Overhaul Unclassified Borrow	Station Yard
1213	Overhaul Unclassified Borrow	Mile Yard
1214	Overhaul Channel Excavation	Station Yard
1215	Overhaul Channel Excavation	Mile Yard
1220	Overhaul Special Borrow	Station Yard
1221	Overhaul Special Borrow	Mile Yard

		Ton Mile	Yard Mile
Haul	Selected Surfacing	1310	1350
Haul	Sand Surfacing	1311	1351
Haul	Base Surfacing	1312	1352
Haul	Type A Top Surfacing	1314	1354
Haul	Type B Top Surfacing	1315	1355
Haul	Cover Material	1316	1356
Haul	Stone Chips	1317	1357
Haul	Binder	1318	1358
Haul	Top Soil	1320	1360
Haul	Stockpiled Selected Surfacing	1321	1361
Haul	Stockpiled Base Surfacing	1322	1362
Haul	Stockpiled Type A Top	1324	1364
Haul	Stockpiled Type B Top	1325	1365
Haul	Stockpiled Cover Material	1326	1366
Haul	Stockpiled Stone Chips	1327	1367
Haul	Stockpiled Top Soil	1328	1368
Haul	Aggregate	1390	1391
1403	Roll Subgrade		Unit
1404	Roll Surface Course		Unit
1410	Rolling		Unit

SECTION 100

1450	Mechanical Tamping	Hour
1501	Furnish and Maintain Water Plant	Lump Sum
1503	Water Subgrade	M. Gallon
1504	Water Surface Courses	M. Gallon
1506	Water Detour	M. Gallon
1510	Watering	M. Gallon
1601	Use of Motor Grader	Hour
1602	Use of Dozer	Hour
1603	Use of Shovel	Hour
1604	Use of Scraper	Hour
1605	Use of Tractor-Loader	Hour
1606	Use of Aggregate Spreader	Hour
1607	Use of Dragline	Hour
1611	Surface Preparation	Mile
1614	Surface Preparation	Station
1617	Surface Removal	Square Yard
1621	Surface Removal	Mile
1624	Surface Removal	Station
1627	Surface Removal	Square Yard
1631	Traffic Provisions—Schedule 1	Hour
1632	Traffic Provisions—Schedule 2	Hour
1633	Traffic Provisions—Schedule 3	Hour
1641	Obliterate Roadway	Mile
1642	Obliterate Roadway	Station
1643	Obliterate Roadway	Square Yard
1644	Obliterate Roadway	Cubic Yard
1701	Topsoil	Cubic Yard
1702	Topsoil—Stockpiled	Cubic Yard
1705	Use of Motor Grader	Hour
1710	Seeding	Pound
1711	Seeding	Acre
1712	Seeding	Square Yard
1713	Seed and Fertilize	Acre
1715	Fertilize	Ton
1716	Condition Seedbed Surface	Hour
1717	Use and Apply Water	M. Gallon
1721	Mulching	Acre
1722	Mulching	Square Yard
1723	Vegetative Mulch	Ton
1727	SS-1 Emulsified Asphalt	Gallon
1730	Fabricated Mulch	Square Yard
1731	Fabricated Netting	Square Yard
Cubic Yard		Ton
Special Selected Surfacing	2110	2120
4 inch Selected Surfacing	2111	2121
3 inch Selected Surfacing	2112	2122
2½ inch Selected Surfacing	2113	2123
2 inch Selected Surfacing	2114	2124
1½ inch Selected Surfacing	2115	2125
1 inch Selected Surfacing	2116	2126
1½ inch Sand Surfacing	2151	2161
1 inch Sand Surfacing	2152	2162
¾ inch Sand Surfacing	2153	2163
½ inch Sand Surfacing	2154	2164
No. 4 Sand Surfacing	2155	2165
1 inch Special Sand Surfacing	2156	2166
Barrel		
2231	Portland Cement	Barrel
2232	Process 0.35' Cement Stabilized Base	Square Yard
2233	Process 0.40' Cement Stabilized Base	Square Yard
2234	Process 0.50' Cement Stabilized Base	Square Yard
2235	Process 0.60' Cement Stabilized Base	Square Yard
2236	Process 0.70' Cement Stabilized Base	Square Yard
2237	Process 0.75' Cement Stabilized Base	Square Yard
2238	Process 0.85' Cement Stabilized Base	Square Yard
2240	Mineral Aggregate	Cubic Yard
2241	Mineral Aggregate	Ton
2245	Blotter Material	Cubic Yard
2246	Blotter Material	Ton

		Cubic Yard	Ton
4	inch Type A Base Surfacing	2310	2330
3	inch Type A Base Surfacing	2311	2331
2½	inch Type A Base Surfacing	2312	2332
2	inch Type A Base Surfacing	2313	2333
1½	inch Type A Base Surfacing	2314	2334
1	inch Type A Base Surfacing	2315	2335
2	inch Type B Base Surfacing	2323	2343
1½	inch Type B Base Surfacing	2324	2344
1	inch Type B Base Surfacing	2335	2345
1	inch Type A Top Surfacing	2501	2511
¾	inch Type A Top Surfacing	2502	2512
⅝	inch Type A Top Surfacing	2503	2513
½	inch Type A Top Surfacing	2504	2514
⅜	inch Type A Top Surfacing	2505	2515
1½	inch Type B Top Surfacing	2521	2531
1	inch Type B Top Surfacing	2522	2532
¾	inch Type B Top Surfacing	2523	2533
	Mineral Filler	2610	2620
	Binder	2650	2660
¾	inch Cover Material	2711	2716
⅝	inch Cover Material	2712	2717
½	inch Cover Material	2713	2718
⅜	inch Cover Material	2714	2719
½	inch Stone Chips	2721	2726
⅝	inch Stone Chips	2722	2727
No. 4	Stone Chips	2723	2728
Stockpile	Special Selected Surfacing	2800	2810
Stockpile	4 inch Selected Surfacing	2801	2811
Stockpile	3 inch Selected Surfacing	2802	2812
Stockpile	2½ inch Selected Surfacing	2803	2813
Stockpile	2 inch Selected Surfacing	2804	2814
Stockpile	1½ inch Selected Surfacing	2805	2815
Stockpile	1 inch Selected Surfacing	2806	2816
Stockpile	4 inch Type A Base Surfacing	2821	2831
Stockpile	3 inch Type A Base Surfacing	2822	2832
Stockpile	2½ inch Type A Base Surfacing	2823	2833
Stockpile	2 inch Type A Base Surfacing	2824	2834
Stockpile	1½ inch Type A Base Surfacing	2825	2835
Stockpile	1 inch Type A Base Surfacing	2826	2836
Stockpile	2 inch Type B Base Surfacing	2827	2837
Stockpile	1½ inch Type B Base Surfacing	2828	2838
Stockpile	1 inch Type B Base Surfacing	2829	2839
Stockpile	1 inch Type A Top Surfacing	2861	2871
Stockpile	¾ inch Type A Top Surfacing	2862	2872
Stockpile	⅝ inch Type A Top Surfacing	2863	2873
Stockpile	½ inch Type A Top Surfacing	2864	2874
Stockpile	⅜ inch Type A Top Surfacing	2865	2875
Stockpile	1½ inch Type B Top Surfacing	2867	2877
Stockpile	1 inch Type B Top Surfacing	2868	2878
Stockpile	¾ inch Type B Top Surfacing	2869	2879
Stockpile	⅔ inch Cover Material	2881	2891
Stockpile	⅝ inch Cover Material	2882	2892
Stockpile	½ inch Cover Material	2883	2893
Stockpile	⅓ inch Cover Material	2884	2894
Stockpile	½ inch Stone Chips	2885	2895
Stockpile	⅓ inch Stone Chips	2886	2896
Stockpile No. 4	Stone Chips	2887	2897

See Section 97 for Stockpiled Materials where there is no Federal Aid participation in the cost.

Abbreviations will be used in some of the bitumens. "50-60 Asphalt Cement" is an abbreviation for "50-60 Penetration Asphalt Cement."

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		Gallon	Ton
	Bituminous Material Additive	3000	
	Emulsified Asphalt	3001	3101
50-60	Asphalt Cement	3010	3110
60-70	Asphalt Cement	3011	3111
70-85	Asphalt Cement	3012	3112
85-100	Asphalt Cement	3013	3113
100-120	Asphalt Cement	3014	3114
120-150	Asphalt Cement	3015	3115
150-200	Asphalt Cement	3016	3116
RC-0	Cutback Asphalt	3020	3120
RC-1	Cutback Asphalt	3021	3121
RC-2	Cutback Asphalt	3022	3122
RC-3	Cutback Asphalt	3023	3123
RC-4	Cutback Asphalt	3024	3124
RC-5	Cutback Asphalt	3025	3125
MC-0	Cutback Asphalt	3030	3130
MC-1	Cutback Asphalt	3031	3131
MC-2	Cutback Asphalt	3032	3132
MC-3	Cutback Asphalt	3033	3133
MC-4	Cutback Asphalt	3034	3134
MC-5	Cutback Asphalt	3035	3135
SC-0	Cutback Asphalt	3040	3140
SC-1	Cutback Asphalt	3041	3141
SC-2	Cutback Asphalt	3042	3142
SC-3	Cutback Asphalt	3043	3143
SC-4	Cutback Asphalt	3044	3144
SC-5	Cutback Asphalt	3045	3145
SC-6	Cutback Asphalt	3046	3146
RS-1	Emulsified Asphalt	3051	3151
RS-2	Emulsified Asphalt	3052	3152
RS-2C	Cationic Emulsified Asphalt	3053	3153
MS-2	Emulsified Asphalt	3054	3154
SS-1	Emulsified Asphalt	3055	3155
SS-1h	Emulsified Asphalt	3056	3156
RC-3D	Rubberized Cutback Asphalt	3065	3165
RC-4D	Rubberized Cutback Asphalt	3066	3166
RC-5D	Rubberized Cutback Asphalt	3067	3167
RC-6D	Rubberized Cutback Asphalt	3068	3168
	Apply Prime Coat	3210	3230
	Apply Tack Coat	3220	3240
	Furnish Prime Coat Material	3215	3235
	Furnish Tack Coat Material	3225	3245

		Cubic Yard	Ton
	Apply $\frac{3}{4}$ inch Cover Aggregate	3311	3312
	Apply $\frac{5}{8}$ inch Cover Aggregate	3321	3322
	Apply $\frac{1}{2}$ inch Cover Aggregate	3331	3332
	Apply $\frac{3}{8}$ inch Cover Aggregate	3341	3342
	Apply Sand Aggregate	3351	3352

The following items are by the mile:

3411	Process 24' x 0.10' Bituminous Mat
3412	Process 24' x 0.15' Bituminous Mat
3413	Process 24' x 0.20' Bituminous Mat
3414	Process 24' x 0.25' Bituminous Mat
3421	Process 26' x 0.10' Bituminous Mat
3422	Process 26' x 0.15' Bituminous Mat
3423	Process 26' x 0.20' Bituminous Mat
3424	Process 26' x 0.25' Bituminous Mat
3431	Process 28' x 0.10' Bituminous Mat
3432	Process 28' x 0.15' Bituminous Mat
3433	Process 28' x 0.20' Bituminous Mat
3434	Process 28' x 0.25' Bituminous Mat
3441	Process 30' x 0.10' Bituminous Mat
3442	Process 30' x 0.15' Bituminous Mat
3443	Process 30' x 0.20' Bituminous Mat
3444	Process 30' x 0.25' Bituminous Mat

3451	Process 32' x 0.10' Bituminous Mat
3452	Process 32' x 0.15' Bituminous Mat
3453	Process 32' x 0.20' Bituminous Mat
3454	Process 32' x 0.25' Bituminous Mat

The following items are by the Square Yard:

3481	Process 0.10' Bituminous Mat
3482	Process 0.15' Bituminous Mat
3483	Process 0.20' Bituminous Mat
3484	Process 0.25' Bituminous Mat

The following items are by the Ton:

3511	Type 1 Plant Mix Bituminous Surfacing
3512	Type 1 Plant Mix Bituminous Surfacing
3513	Type 1 Plant Mix Bituminous Surfacing
3514	Type 1 Plant Mix Bituminous Surfacing
3521	Type 2 Plant Mix Bituminous Surfacing
3522	Type 2 Plant Mix Bituminous Surfacing
3523	Type 2 Plant Mix Bituminous Surfacing
3524	Type 2 Plant Mix Bituminous Surfacing
3531	Type 3 Plant Mix Bituminous Surfacing
3532	Type 3 Plant Mix Bituminous Surfacing
3533	Type 3 Plant Mix Bituminous Surfacing
3534	Type 3 Plant Mix Bituminous Surfacing
3511, 3521 and 3531	include all courses.

When 3512, 3522 and 3532 are specified, the material will be used as a leveling course.

When 3513 or 3523 are specified, the material is to be used as first course.

When 3533 is specified, the material is to be used as base course.

When 3514 or 3524 are specified, the material is to be used as second or final course.

When 3534 is specified, the material is to be used as wearing course.

		Cubic Yard	Ton
Apply	5/8 inch Cover Material	-----	3611
Apply	1/2 inch Cover Material	-----	3621
Apply	3/8 inch Cover Material	-----	3631
Apply	1/2 inch Stone Chips	-----	3641
Apply	3/8 inch Stone Chips	-----	3651
Apply	5/8 inch Top Course Surfacing	-----	3661
			3662

The Unit is Square Yard for the following in the 39- group:

3906	6 inch PC Concrete Pavement	
3907	7 inch PC Concrete Pavement	
3908	8 inch PC Concrete Pavement	
3909	9 inch PC Concrete Pavement	
3910	10 inch PC Concrete Pavement	
3916	6 inch RPC Concrete Pavement	RPC means
3917	7 inch RPC Concrete Pavement	Reinforced
3918	8 inch RPC Concrete Pavement	Portland
3919	9 inch RPC Concrete Pavement	Cement
3920	10 inch RPC Concrete Pavement	

4101	Revise Concrete Bridge	Lump Sum
4110	Floor Drain-Concrete Structure	Each
4119	30 Foot Prestressed Beam—Type A	Each
4120	35 Foot Prestressed Beam—Type A	Each
4121	40 Foot Prestressed Beam—Type A	Each
4122	45 Foot Prestressed Beam—Type A	Each
4123	50 Foot Prestressed Beam—Type A	Each
4124	55 Foot Prestressed Beam—Type A	Each
4125	60 Foot Prestressed Beam—Type A	Each
4126	65 Foot Prestressed Beam—Type A	Each
4127	70 Foot Prestressed Beam—Type A	Each
4128	75 Foot Prestressed Beam—Type A	Each
4129	80 Foot Prestressed Beam—Type A	Each

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4135	25 Foot Prestressed Beam—Type B	Each
4136	30 Foot Prestressed Beam—Type B	Each
4137	35 Foot Prestressed Beam—Type B	Each
4138	40 Foot Prestressed Beam—Type B	Each
4139	45 Foot Prestressed Beam—Type B	Each
4140	50 Foot Prestressed Beam—Type B	Each
4210	Dismantle and Erect Truss	Lump Sum
4220	Floor Drain-Steel Structure	Each
4310	Timber Truss	Lineal Foot
4510	Structure Excavation	Cubic Yard
4511	Structure Excavation	Lump Sum
4520	Type 1 Structure Excavation	Cubic Yard
4521	Type 1 Structure Excavation	Lump Sum
4530	Type 2 Structure Excavation	Cubic Yard
4531	Type 2 Structure Excavation	Lump Sum
4550	Shoring and Cribs	Lump Sum
		Cubic Yard Lump Sum
	Class A Concrete	4610 4611
	Class AD Concrete	4612 4613
	Class DD Concrete	4618 4619
	Class S Concrete	4620 4621

Class AP Concrete will be paid for under Section 39.

4710	Reinforcing Steel	Pound
4810	Structural Steel	Pound
4811	Structural Steel	Lump Sum
4910	Bronze Bearing Plates	Pound
4911	Bronze Bearing Plates	Lump Sum
4920	Cast Steel	Pound
4921	Cast Steel	Lump Sum
5110	Untreated Timber	M.b.m.
5111	Furnish Untreated Timber	M.b.m.
5112	Install Untreated Timber	M.b.m.
5120	Treated Timber	M.b.m.
5121	Furnish Treated Timber	M.b.m.
5122	Install Treated Timber	M.b.m.
5200	Prebored Holes for Piles	Lineal Foot
5202	Pile Shoes	Each
5210	Untreated Timber Test Piles	Lump Sum
5211	Treated Timber Test Piles	Lump Sum
5212	Loading Test Piles	Each
5214	Steel Test Piles	Lump Sum
5215	Furnish Steel Bearing Piles	Pound
5216	Drive Steel Bearing Piles	Lineal Foot
5217	Steel Bearing Piles in Place	Lump Sum
5220	15 Foot Treated Timber Piles	Each
5221	20 Foot Treated Timber Piles	Each
5222	25 Foot Treated Timber Piles	Each
5223	30 Foot Treated Timber Piles	Each
5224	35 Foot Treated Timber Piles	Each
5225	40 Foot Treated Timber Piles	Each
5226	45 Foot Treated Timber Piles	Each
5227	50 Foot Treated Timber Piles	Each
5228	55 Foot Treated Timber Piles	Each
5229	60 Foot Treated Timber Piles	Each
5230	65 Foot Treated Timber Piles	Each
5231	Furnish Treated Timber Piles	Lineal Foot
5232	Drive Treated Timber Piles	Lineal Foot
5236	Furnish Untreated Timber Piles	Lineal Foot
5237	Drive Untreated Timber Piles	Lineal Foot
5238	Untreated Timber Piles in Place	Lineal Foot

5250	Furnish Precast Concrete Piles	Lineal Foot
5251	Drive Precast Concrete Piles	Lineal Foot
5252	20 Foot Precast Concrete Piles	Each
5253	22 Foot Precast Concrete Piles	Each
5254	24 Foot Precast Concrete Piles	Each
5255	26 Foot Precast Concrete Piles	Each
5256	28 Foot Precast Concrete Piles	Each
5257	30 Foot Precast Concrete Piles	Each
5258	32 Foot Precast Concrete Piles	Each
5259	34 Foot Precast Concrete Piles	Each
5260	36 Foot Precast Concrete Piles	Each
5261	38 Foot Precast Concrete Piles	Each
5262	40 Foot Precast Concrete Piles	Each
5309	Aluminum Beam Bridge Rail	Lineal Foot
5310	Steel Beam Bridge Rail	Lineal Foot
5314	Pipe Rail	Lineal Foot
5316	Ornamental Rail	Lineal Foot
5317	Ornamental Rail	Lump Sum
5318	Concrete Rail	Lineal Foot
5320	Concrete Curb and Rail	Lineal Foot
5322	Concrete Curb	Lineal Foot
5323	Integral Slab, Median and Curb	Lump Sum
5324	Integral Curb and Sidewalk	Lump Sum
5325	Corrugated Asbestos-Cement Sheets	Lump Sum
5326	Guard Fence	Lineal Foot
5327	Weighted Slab	Lump Sum
5328	Galvanized Iron	Square Foot
5329	Galvanized Iron	Lump Sum
5330	Type A Asphalt Plank	Square Foot
5331	Type B Asphalt Plank	Square Foot
5332	Type A Asphalt Plank	Lump Sum
5333	Type B Asphalt Plank	Lump Sum
5335	Waterproofing	Lump Sum
5337	Coal-Tar Waterproofing	Square Foot
5340	Drainage System	Lump Sum
5350	Stairway	Lump Sum
5410	Paint Traffic Lines—Plain	Lump Sum
5411	Paint Traffic Lines—Beaded	Lump Sum
5420	Paint Traffic Lines—Plain	Square Yard
5421	Paint Traffic Lines—Beaded	Square Yard
5430	Paint Traffic Lines—Plain	Mile
5431	Paint Traffic Lines—Beaded	Mile
5710	Hand-Laid Riprap	Cubic Yard
5720	Type A Random Riprap	Cubic Yard
5722	Type B Random Riprap	Cubic Yard
5730	Grouted Riprap	Square Yard
5740	Sacked Concrete Riprap	Cubic Yard
5750	Concrete Slab Riprap	Cubic Yard
5810	Dry Rubble Masonry	Cubic Yard
5820	Cement Rubble Masonry	Cubic Yard
5910	Hand-Laid Rock Embankment	Cubic Yard
5911	Hand-Laid Rock Embankment	Lump Sum
6110	Remove Pipe Culverts	Lineal Foot
6111	Remove Pipe Culverts	Lump Sum
6120	Relay Pipe Culverts	Lineal Foot
6121	Relay Pipe Culverts	Lump Sum
6130	Remove and Relay Pipe Culverts	Lineal Foot
6131	Remove and Relay Pipe Culverts	Lump Sum
6210	Backfill Material	Cubic Yard
6220	Grade 1 Backfill Material	Cubic Yard
6230	Grade 2 Backfill Material	Cubic Yard
6240	Grade 3 Backfill Material	Cubic Yard

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The Unit of measurement for all pipe culverts is the lineal foot.

When the following numbers are used in the fifth column of item numbers for metal culverts, the meaning will be as shown below:

- 1—Fully Bituminous Coated—Type A
- 2—Half Bituminous Paved Invert—Type B
- 3—Fully Bituminous Coated and Paved—Type C
- 4—Bituminized—Type D
- 5—Asbestos-Bond—Type E

6301	30" CMP Culvert	8 gage
6302	30" CMP Culvert—Irrigation	8 gage
6308	8" CMP Culvert	16 gage
6309	8" CMP Culvert—Irrigation	16 gage
6311	10" CMP Culvert	16 gage
6312	12" CMP Culvert	16 gage
6313	12" CMP Culvert—Irrigation	16 gage
6315	15" CMP Culvert	16 gage
6316	15" CMP Culvert—Irrigation	16 gage
6318	18" CMP Culvert	16 gage
6319	18" CMP Culvert—Irrigation	16 gage
6320	18" CMP Culvert	14 gage
6321	18" CMP Culvert—Irrigation	14 gage
6322	18" CMP Culvert	12 gage
6323	18" CMP Culvert—Irrigation	12 gage
6324	24" CMP Culvert	14 gage
6325	24" CMP Culvert—Irrigation	14 gage
6326	24" CMP Culvert	12 gage
6327	24" CMP Culvert—Irrigation	12 gage
6328	24" CMP Culvert	10 gage
6329	24" CMP Culvert—Irrigation	10 gage
6330	30" CMP Culvert	14 gage
6331	30" CMP Culvert—Irrigation	14 gage
6332	30" CMP Culvert	12 gage
6333	30" CMP Culvert—Irrigation	12 gage
6334	30" CMP Culvert	10 gage
6335	30" CMP Culvert—Irrigation	10 gage
6336	36" CMP Culvert	12 gage
6337	36" CMP Culvert—Irrigation	12 gage
6338	36" CMP Culvert	10 gage
6339	36" CMP Culvert—Irrigation	10 gage
6340	36" CMP Culvert	8 gage
6341	36" CMP Culvert—Irrigation	8 gage
6342	42" CMP Culvert	12 gage
6343	42" CMP Culvert—Irrigation	12 gage
6344	42" CMP Culvert	10 gage
6345	42" CMP Culvert—Irrigation	10 gage
6346	42" CMP Culvert	8 gage
6347	42" CMP Culvert—Irrigation	8 gage
6348	48" CMP Culvert	12 gage
6349	48" CMP Culvert—Irrigation	12 gage
6350	48" CMP Culvert	10 gage
6351	48" CMP Culvert—Irrigation	10 gage
6352	48" CMP Culvert	8 gage
6353	48" CMP Culvert—Irrigation	8 gage
6354	54" CMP Culvert	12 gage
6355	54" CMP Culvert—Irrigation	12 gage
6356	54" CMP Culvert	10 gage
6357	54" CMP Culvert—Irrigation	10 gage
6358	54" CMP Culvert	8 gage
6359	54" CMP Culvert—Irrigation	8 gage
6360	60" CMP Culvert	10 gage
6361	60" CMP Culvert—Irrigation	10 gage
6362	60" CMP Culvert	8 gage
6363	60" CMP Culvert—Irrigation	8 gage
6366	66" CMP Culvert	10 gage
6368	66" CMP Culvert	8 gage
6372	72" CMP Culvert	10 gage
6374	72" CMP Culvert	8 gage
6378	78" CMP Culvert	8 gage
6384	84" CMP Culvert	8 gage

6390	21" CMP Culvert	16 gage
6391	21" CMP Culvert	16 gage
6401	22" x 13" CMP Arch Culvert—Irrigation	14 gage
6402	36" x 22" CMP Arch Culvert—Irrigation	8 gage
6418	18" x 11" CMP Arch Culvert	16 gage
6419	18" x 11" CMP Arch Culvert—Irrigation	16 gage
6422	22" x 13" CMP Arch Culvert	16 gage
6423	22" x 13" CMP Arch Culvert—Irrigation	16 gage
6424	22" x 13" CMP Arch Culvert	14 gage
6425	25" x 16" CMP Arch Culvert	16 gage
6426	25" x 16" CMP Arch Culvert—Irrigation	16 gage
6427	25" x 16" CMP Arch Culvert	14 gage
6428	25" x 16" CMP Arch Culvert—Irrigation	14 gage
6429	29" x 18" CMP Arch Culvert	14 gage
6430	29" x 18" CMP Arch Culvert—Irrigation	14 gage
6431	29" x 18" CMP Arch Culvert	12 gage
6432	29" x 18" CMP Arch Culvert—Irrigation	12 gage
6433	29" x 18" CMP Arch Culvert	10 gage
6434	29" x 18" CMP Arch Culvert—Irrigation	10 gage
6436	36" x 22" CMP Arch Culvert	14 gage
6437	36" x 22" CMP Arch Culvert—Irrigation	14 gage
6438	36" x 22" CMP Arch Culvert	12 gage
6439	36" x 22" CMP Arch Culvert—Irrigation	12 gage
6440	36" x 22" CMP Arch Culvert	10 gage
6441	36" x 22" CMP Arch Culvert—Irrigation	10 gage
6442	36" x 22" CMP Arch Culvert	8 gage
6443	43" x 27" CMP Arch Culvert	12 gage
6444	43" x 27" CMP Arch Culvert—Irrigation	12 gage
6445	43" x 27" CMP Arch Culvert	10 gage
6446	43" x 27" CMP Arch Culvert—Irrigation	10 gage
6447	43" x 27" CMP Arch Culvert	8 gage
6448	43" x 27" CMP Arch Culvert—Irrigation	8 gage
6450	50" x 31" CMP Arch Culvert	12 gage
6451	50" x 31" CMP Arch Culvert—Irrigation	12 gage
6452	50" x 31" CMP Arch Culvert	10 gage
6453	50" x 31" CMP Arch Culvert—Irrigation	10 gage
6454	50" x 31" CMP Arch Culvert	8 gage
6455	50" x 31" CMP Arch Culvert—Irrigation	8 gage
6458	58" x 36" CMP Arch Culvert	12 gage
6459	58" x 36" CMP Arch Culvert—Irrigation	12 gage
6460	58" x 36" CMP Arch Culvert	10 gage
6461	58" x 36" CMP Arch Culvert—Irrigation	10 gage
6462	58" x 36" CMP Arch Culvert	8 gage
6463	58" x 36" CMP Arch Culvert—Irrigation	8 gage
6465	65" x 40" CMP Arch Culvert	12 gage
6466	65" x 40" CMP Arch Culvert—Irrigation	12 gage
6467	65" x 40" CMP Arch Culvert	10 gage
6468	65" x 40" CMP Arch Culvert—Irrigation	10 gage
6469	65" x 40" CMP Arch Culvert	8 gage
6470	65" x 40" CMP Arch Culvert—Irrigation	8 gage
6472	72" x 44" CMP Arch Culvert	10 gage
6473	72" x 44" CMP Arch Culvert—Irrigation	10 gage
6474	72" x 44" CMP Arch Culvert	8 gage
6475	72" x 44" CMP Arch Culvert—Irrigation	8 gage
6500	Structural Plate Stockpass	Design A
6501	Structural Plate Stockpass	Design B
6502	102" SPP Culvert	10 gage
6503	102" SPP Culvert	8 gage
6508	108" SPP Culvert	10 gage
6509	108" SPP Culvert	8 gage
6514	114" SPP Culvert	10 gage
6515	114" SPP Culvert	8 gage
6520	120" SPP Culvert	10 gage
6521	120" SPP Culvert	8 gage
6522	120" SPP Culvert	7 gage
6526	126" SPP Culvert	10 gage
6527	126" SPP Culvert	8 gage
6532	132" SPP Culvert	10 gage
6533	132" SPP Culvert	8 gage

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6538	138"	SPP Culvert	10	gage
6539	138"	SPP Culvert	8	gage
6544	144"	SPP Culvert	10	gage
6545	144"	SPP Culvert	8	gage
6546	144"	SPP Culvert	7	gage
6547	144"	SPP Culvert	5	gage
6556	156"	SPP Culvert	10	gage
6557	156"	SPP Culvert	8	gage
6559	156"	SPP Culvert	7	gage
6560	60"	SPP Culvert	10	gage
6561	60"	SPP Culvert	8	gage
6566	66"	SPP Culvert	10	gage
6567	66"	SPP Culvert	8	gage
6568	168"	SPP Culvert	10	gage
6569	168"	SPP Culvert	8	gage
6570	66"	SPP Culvert	3	gage
6571	66"	SPP Culvert	10	gage
6572	72"	SPP Culvert	10	gage
6573	72"	SPP Culvert	8	gage
6576	180"	SPP Culvert	10	gage
6578	78"	SPP Culvert	10	gage
6579	78"	SPP Culvert	8	gage
6580	180"	SPP Culvert	8	gage
6581	180"	SPP Culvert	7	gage
6582	180"	SPP Culvert	5	gage
6583	180"	SPP Culvert	3	gage
6584	84"	SPP Culvert	10	gage
6585	84"	SPP Culvert	8	gage
6587	84"	SPP Culvert	5	gage
6589	84"	SPP Culvert	1	gage
6590	90"	SPP Culvert	10	gage
6591	90"	SPP Culvert	8	gage
6592	90"	SPP Culvert	7	gage
6596	96"	SPP Culvert	10	gage
6597	96"	SPP Culvert	8	gage
6598	96"	SPP Culvert	7	gage
6599	180"	SPP Culvert	1	gage
6601	6' 1"	SPP Arch Culvert	12	gage
6602	6' 1"	SPP Arch Culvert	10	gage
6605	6' 9"	SPP Arch Culvert	12	gage
6606	6' 9"	SPP Arch Culvert	10	gage
6609	7' 3"	SPP Arch Culvert	12	gage
6610	7' 3"	SPP Arch Culvert	10	gage
6613	7' 11"	SPP Arch Culvert	12	gage
6614	7' 11"	SPP Arch Culvert	10	gage
6616	8' 7"	SPP Arch Culvert	10	gage
6617	8' 7"	SPP Arch Culvert	8	gage
6621	9' 4"	SPP Arch Culvert	10	gage
6622	9' 4"	SPP Arch Culvert	8	gage
6623	9' 4"	SPP Arch Culvert	7	gage
6627	9' 9"	SPP Arch Culvert	10	gage
6628	9' 9"	SPP Arch Culvert	8	gage
6629	9' 9"	SPP Arch Culvert	7	gage
6633	10' 8"	SPP Arch Culvert	10	gage
6634	10' 8"	SPP Arch Culvert	8	gage
6635	10' 8"	SPP Arch Culvert	7	gage
6639	11' 5"	SPP Arch Culvert	10	gage
6640	11' 5"	SPP Arch Culvert	8	gage
6641	11' 5"	SPP Arch Culvert	7	gage
6645	11' 10"	SPP Arch Culvert	8	gage
6646	11' 10"	SPP Arch Culvert	7	gage
6647	11' 10"	SPP Arch Culvert	5	gage
6651	12' 6"	SPP Arch Culvert	8	gage
6652	12' 6"	SPP Arch Culvert	7	gage
6653	12' 6"	SPP Arch Culvert	5	gage
6657	12' 10"	SPP Arch Culvert	8	gage
6658	12' 10"	SPP Arch Culvert	7	gage
6659	12' 10"	SPP Arch Culvert	5	gage
6666	14' 0"	SPP Arch Culvert	10	gage
6672	14' 4"	SPP Arch Culvert	10	gage

6678	16' 6" SPP Arch Culvert	8 gage
6684	17' 11" SPP Arch Culvert	8 gage
6690	19' 3" SPP Arch Culvert	7 gage
6695	20' 5" SPP Arch Culvert	7 gage

The next two groups apply to concrete pipes. They are numbered and handled somewhat different than metal pipes. The first four digits are the true item numbers; the fifth digit designates the class of culvert—I, II, III, IV or V—and use, 1, 2, 3, 4 and 5 will designate the class when the pipe is used for ordinary and drainage purposes; 6, 7, 8, 9 and 0 will indicate the respective classes when the pipe is used for irrigation and other purposes requiring a tight joint. The third and fourth digits of the item number indicate the pipe diameter; e. g., 6812 denotes 12" diameter; 6802 denotes 102" diameter. An item description shall be as follows: "102 in. RCP Culvert—Class 3." The unit measurement is the lineal foot.

6802	102" RCP Culvert	The word "Class 4" or similar will follow each description.
6808	108" RCP Culvert	
6812	12" RCP Culvert	
6815	15" RCP Culvert	
6818	18" RCP Culvert	
6821	21" RCP Culvert	
6824	24" RCP Culvert	
6827	27" RCP Culvert	
6830	30" RCP Culvert	
6833	33" RCP Culvert	
6836	36" RCP Culvert	
6842	42" RCP Culvert	
6848	48" RCP Culvert	
6854	54" RCP Culvert	
6860	60" RCP Culvert	
6866	66" RCP Culvert	
6872	72" RCP Culvert	
6878	78" RCP Culvert	
6884	84" RCP Culvert	
6890	90" RCP Culvert	
6896	96" RCP Culvert	

Concrete Arch Culverts have a special numbering system. The third and fourth digits are the true item number. Concrete pipe-arches are not constructed by classes, as are round pipes. The figure "8" will be used as the fifth digit to indicate arch pipe use where a water-tight joint is necessary. The arch dimensions given below are the nearest inch, with "½" being called the next whole number. The unit of measurement is the lineal foot. First dimension is rise; second is span.

6902	72" x 48"	Concrete Underpass
6903	84"	Concrete Stockpass-Flat Bottom
6924	18" x 29"	RCP Arch Culvert
6930	23" x 36"	RCP Arch Culvert
6936	27" x 44"	RCP Arch Culvert
6942	31" x 51"	RCP Arch Culvert
6948	36" x 59"	RCP Arch Culvert
6954	40" x 65"	RCP Arch Culvert
6960	45" x 74"	RCP Arch Culvert
6972	54" x 88"	RCP Arch Culvert

Section 70—Numbers will be assigned as occasion demands.

7110	Metal Ditch Lining	Lineal Foot
7120	Metal Flume	Lineal Foot
7130	Timber Ditch Lining	M.b.m.
7140	Timber Flume	M.b.m.
7150	Concrete Headgates	Each
7160	15" Metal Headgate	Each
7161	18" Metal Headgate	Each
7162	24" Metal Headgate	Each
7163	30" Metal Headgate	Each
7164	36" Metal Headgate	Each
7170	18" Wood Headgate	Each
7171	24" Wood Headgate	Each

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7172	30" Wood Headgate	Each
7173	36" Wood Headgate	Each
7175	Headgate Lumber	M.b.m.
7301	Revise Structure	Lump Sum
7305	Revise Structure and Maintain Traffic	Lump Sum
7402	Concrete Curb	Lineal Foot
7404	Concrete Curb and Gutter	Lineal Foot
7406	Median Concrete Curb—Type A	Lineal Foot
7408	Median Concrete Curb—Type B	Lineal Foot
7411	Median Concrete Curb	Lineal Foot
7412	Precast Concrete Curb	Lineal Foot
7414	Precast Concrete Curb and Gutter	Lineal Foot
7416	Concrete Cutoff Curb	Lineal Foot
7418	Concrete Gutter	Lineal Foot
7420	Bituminous Curb	Lineal Foot
7422	Bituminous Gutter	Lineal Foot
7424	Bituminous Curb and Gutter	Lineal Foot
7454	4" Concrete Sidewalk	Square Yard
7455	5" Concrete Sidewalk	Square Yard
7456	6" Concrete Sidewalk	Square Yard
7457	Concrete Sidewalk	Lump Sum
7461	Concrete Headwalls for Pipe Culverts	Cubic Yard
7463	Headwalls for Corrugated Metal Pipe	Cubic Yard
7465	Headwalls for Concrete Pipe	Cubic Yard
7467	Concrete Supports for Pipe Culverts	Cubic Yard
7468	Concrete Cutoff Walls	Square Foot
7480	Metal Cutoff Walls	Square Foot
7510	Precast Manhole-Catch Basin	Each
7520	CIP Manhole-Catch Basin	Each
7530	Precast Manhole	Each
7540	Catch Basin	Each
7550	Standard Drop Inlet	Each
7552	Drop Inlet	Each
7571	Type A Median Inlet Cover	Each
7572	Type B Median Inlet Cover	Each
7573	Type C Median Inlet Cover	Each
7577	Manhole Cover	Each
7578	Catch Basin Cover	Each
7610	Metal Retaining Wall	Square Foot
7620	Bituminized Metal Retaining Wall	Square Foot
7901	Use of Dozer	Hour
7902	Type F2W Farm Fence	Rod
7903	Type F2M Farm Fence	Rod
7904	Type F3W Farm Fence	Rod
7905	Type F3M Farm Fence	Rod
7906	Type F4W Farm Fence	Rod
7907	Type F4M Farm Fence	Rod
7908	Type F5W Farm Fence	Rod
7909	Type F5M Farm Fence	Rod
7910	Type F6W Farm Fence	Rod
7911	Type F6M Farm Fence	Rod
7940	Type G-1 Wood Gate	Lineal Foot
7941	Type G-2 Wire Gate	Lineal Foot
7945	Remove Fence	Rod
7946	Move and Reset Fence	Rod
7981	Farm Fence	Rod
7988	Fence Panel	Each
7989	Deadman	Each
7990	Metal Gate	Lineal Foot
7991	Wooden Gate	Lineal Foot
7992	Wire Gate	Lineal Foot
7994	New Posts	Each
7995	New Barbed Wire	Spool
7996	New Woven Wire	Roll
8001	Use of Dozer	Hour
8005	6 ft. Type 1 Chain Link Fence	Lineal Foot

8006	5 ft. Type 1 Chain Link Fence	Lineal Foot
8013	6 ft. Type 2 Chain Link Fence	Lineal Foot
8014	5 ft. Type 2 Chain Link Fence	Lineal Foot
8021	6 ft. Type 3 Chain Link Fence	Lineal Foot
8022	5 ft. Type 3 Chain Link Fence	Lineal Foot
8030	5' 6" Type 1 Gate	Lineal Foot
8031	4' 6" Type 1 Gate	Lineal Foot
8035	5' 6" Type 2 Gate	Lineal Foot
8036	4' 6" Type 2 Gate	Lineal Foot
8040	5' 6" Type 3 Gate	Lineal Foot
8041	4' 6" Type 3 Gate	Lineal Foot
8050	Single Type 1 Panel	Each
8051	Double Type 1 Panel	Each
8054	Single Type 2 Panel	Each
8055	Double Type 2 Panel	Each
8058	Single Type 3 Panel	Each
8059	Double Type 3 Panel	Each
8071	Type 1 Median Fence	Lineal Foot
8072	Type 2 Median Fence	Lineal Foot
8073	Type 3 Median Fence	Lineal Foot
8101	Use of Dozer	Hour
8102	Type F2W Wire Fence	Rod
8103	Type F2M Wire Fence	Rod
8104	Type F3W Wire Fence	Rod
8105	Type F3M Wire Fence	Rod
8106	Type F4W Wire Fence	Rod
8107	Type F4M Wire Fence	Rod
8108	Type F5W Wire Fence	Rod
8109	Type F5M Wire Fence	Rod
8110	Type CW Wire Fence	Rod
8111	Type CM Wire Fence	Rod
8115	CB4M Wire Fence	Rod
8116	CB4W Wire Fence	Rod
8117	CB5M Wire Fence	Rod
8118	CB5W Wire Fence	Rod
8120	Deadman	Each
8125	Single CW Fence Panel	Each
8126	Double CW Fence Panel	Each
8127	FW Fence Panel	Each
8128	FM Fence Panel	Each
8130	Single CM Fence Panel	Each
8131	Double CM Fence Panel	Each
8140	Wood Gate	Lineal Foot
8141	Wire Gate	Lineal Foot
8142	Metal Gate	Lineal Foot
8145	Remove Fence	Rod
8146	Move and Reset Fence	Rod
8151	Type 1 Median Fence	Rod
8152	Type 2 Median Fence	Rod
8212	12 foot Cattle Guard	Each
8218	18 foot Cattle Guard	Each
8224	24 foot Cattle Guard	Each
8230	30 foot Cattle Guard	Each
8236	36 foot Cattle Guard	Each
8310	Single Height Wood Slat Snow Fence	Lineal Foot
8320	Double Height Wood Slat Snow Fence	Lineal Foot
8601	Conduit System	Lump Sum
8602	Duct System	Lump Sum
8603	Modify Conduit System	Lump Sum
86053	Bituminous Fibre Duct-Type 2-3 inch	Lineal Foot
86054	Bituminous Fibre Duct-Type 2-4 inch	Lineal Foot
86063	Double Bituminous Fibre Duct-Type 2-3 inch	Lineal Foot
86064	Double Bituminous Fibre Duct-Type 2-4 inch	Lineal Foot
86103	Asbestos-Cement Duct-Type 2-3 inch	Lineal Foot
86104	Asbestos-Cement Duct-Type 2-4 inch	Lineal Foot
86113	Double Asbestos-Cement Duct-Type 2-3 inch	Lineal Foot
86114	Double Asbestos-Cement Duct-Type 2-4 inch	Lineal Foot

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86153	Bituminous Fibre Duct-Type 1-3 inch	Lineal	Foot
86154	Bituminous Fibre Duct-Type 1-4 inch	Lineal	Foot
86163	Double Bituminous Fibre Duct-Type 1-3 inch	Lineal	Foot
86164	Double Bituminous Fibre Duct-Type 1-4 inch	Lineal	Foot
86203	Asbestos-Cement Duct-Type 1-3 inch	Lineal	Foot
86204	Asbestos-Cement Duct-Type 1-4 inch	Lineal	Foot
86213	Double Asbestos-Cement Duct-Type 1-3 inch	Lineal	Foot
86214	Double Asbestos-Cement Duct-Type 1-4 inch	Lineal	Foot
8625	1 inch Steel Conduit	Lineal	Foot
8626	1.5 inch Steel Conduit	Lineal	Foot
8627	2 inch Steel Conduit	Lineal	Foot
8628	2.5 inch Steel Conduit	Lineal	Foot
8640	Type 1 Concrete Pull Box		Each
8641	Type 2 Concrete Pull Box		Each
8645	Concrete Manhole		Each

Note: The series 8605 to 8623 will use a 5th digit to denote duct diameter.
E. g. 86054 = 4" duct.

When there are two or more signal or lighting installations in one contract, use the digits 1, 2, 3, etc., to denote each—87011, 87012, 87013, etc.

In the 87— group, certain item numbers will bear a fifth digit, when used on proposal forms and other tabulations, and when done the meaning will be as explained below:

When Item Number 8736 is used the fifth digit will denote the Assembly Number—1, 2, or 3. (Example—87362 means "Guy and Anchor" Assembly No. 2) (abbreviated to "Anchor Assembly" in proposal).

When Item Number 8737 is used the fifth digit will denote the length—1 = 4 ft; 2 = 6 ft; 3 = 8 ft.; 4 = 10 ft.; 5 = 12 ft.; 6 = 14 ft.; 7 = 16 ft.; 8 = 18 ft.; 9 = 20 ft.

When Item Numbers 8738, 8741 and 8745 are used the fifth digit will denote the type—1 = A; 2 = B; 3 = C; 4 = D; 5 = E; 6 = F; 7 = G; 8 = H.

When Item Number 8739 is used the fifth digit 1 is 30 ampere, 2 is 50 ampere, 3 is 100 ampere.

When Item Numbers 8751 and 8752 are used the fifth digit will denote the "way"—1 = one way; 2 = two way; 3 = three way; 4 = four way.

When Item Number 8761 is used the fifth digit will denote the type—1 = Type I; 2 = Type II; 3 = Type III; 4 = Type IV; 5 = Type V. Arabic numbers will be used in proposal for "type."

When Item Number 8763 is used the fifth digit will denote the type—
1 = XXI; 2 = XXII; 3 = XXIII; 4 = XXIV; 5 = XXV; 6 = XXVI; 7 = XXVII. Arabic numbers will be used in proposal for "type."

When Item Numbers 8765 and 8766 are used the fifth digit will mean
—1 = non-directional; 2 = directional.

8701	Signal Installation	Lump	Sum
8702	Signal and Lighting Installation	Lump	Sum
8703	Lighting Installation	Lump	Sum
8704	Electrical Installation	Lump	Sum
8709	Wire Conductor 2 AWG 14 600 V	Lineal	Foot
8710	Wire Conductor 12 AWG 14 600 V	Lineal	Foot
8711	Wire Conductor AWG 14 600 V	Lineal	Foot
8712	Wire Conductor AWG 12 600 V	Lineal	Foot
8713	Wire Conductor AWG 10 600 V	Lineal	Foot
8714	Wire Conductor AWG 8 600 V	Lineal	Foot
8715	Wire Conductor AWG 6 600 V	Lineal	Foot
8716	Wire Conductor AWG 4 600 V	Lineal	Foot
8717	Wire Conductor AWG 2 600 V	Lineal	Foot
8718	Wire Conductor AWG 1 600 V	Lineal	Foot
8719	Wire Conductor AWG 1/0 600 V	Lineal	Foot
8720	Wire Conductor AWG 2/0 600 V	Lineal	Foot
8721	Wire Conductor AWG 3/0 600 V	Lineal	Foot
8722	Wire Conductor AWG 4/0 600 V	Lineal	Foot
8725	Wire Conductor, Duplicate Secondary	Lineal	Foot

8726	Wire Conductor, Triplicate Secondary.....	Lineal Foot
8727	Wire Conductor AWG 8 5000 V.....	Lineal Foot
8728	Wire Conductor AWG 6 Hard-drawn bare.....	Lineal Foot
8729	Wire Conductor 2 AWG 8 5000 V.....	Lineal Foot
8735	Luminaire Assembly.....	Each
87361	Anchor Assembly No. 1.....	Each
87362	Anchor Assembly No. 2.....	Each
87363	Anchor Assembly No. 3.....	Each
87364	Anchor Assembly.....	Each
8737	Lighting Bracket.....	Each
87371	4' Lighting Bracket.....	Each
87372	6' Lighting Bracket.....	Each
87373	8' Lighting Bracket.....	Each
87374	10' Lighting Bracket.....	Each
87375	12' Lighting Bracket.....	Each
87376	14' Lighting Bracket.....	Each
87377	16' Lighting Bracket.....	Each
87378	18' Lighting Bracket.....	Each
87379	20' Lighting Bracket.....	Each
87381	Type A Electrical Service Assembly.....	Each
87382	Type B Electrical Service Assembly.....	Each
87383	Type C Electrical Service Assembly.....	Each
87384	Type D Electrical Service Assembly.....	Each
87385	Type E Electrical Service Assembly.....	Each
87386	Type F Electrical Service Assembly.....	Each
87387	Type G Electrical Service Assembly.....	Each
87388	Type H Electrical Service Assembly.....	Each
8739	Service and Control Assembly.....	Each
87391	Service and Control Assembly—30 Amp.....	Each
87392	Service and Control Assembly—50 Amp.....	Each
87393	Service and Control Assembly—100 Amp.....	Each
8741	Type 1 Signal Standard.....	Each
8742	Type 2 Signal Standard.....	Each
8743	Type 3 Signal Standard.....	Each
8744	Type 4 Signal Standard.....	Each
8745	Controller Cabinet Pedestal.....	Each
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87452	Control Cabinet Pedestal—Type B.....	Each
87453	Control Cabinet Pedestal—Type C.....	Each
87454	Control Cabinet Pedestal—Type D.....	Each
8746	Post for Pedestrian Push Button.....	Each
8751	Traffic Signal—3 color.....	Each
87511	Traffic Signal—3 Color—1 Way.....	Each
87512	Traffic Signal—3 Color—2 Way.....	Each
87513	Traffic Signal—3 Color—3 Way.....	Each
87514	Traffic Signal—3 Color—4 Way.....	Each
87521	Traffic Signal—4 Color—1 Way.....	Each
87522	Traffic Signal—4 Color—2 Way.....	Each
87523	Traffic Signal—4 Color—3 Way.....	Each
87524	Traffic Signal—4 Color—4 Way.....	Each
8755	Pedestrian Signal—Walk-Don't Walk.....	Each
87551	Type 1 Pedestrian Signal.....	Each
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8757	Advance Flashing Beacon.....	Each
87611	Type 1 Traffic-actuated Controller.....	Each
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87613	Type 3 Traffic-actuated Controller.....	Each
87614	Type 4 Traffic-actuated Controller.....	Each
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87632	Type 22 Pre-timed Controller.....	Each
87633	Type 23 Pre-timed Controller.....	Each
87634	Type 24 Pre-timed Controller.....	Each
87635	Type 25 Pre-timed Controller.....	Each
87636	Type 26 Pre-timed Controller.....	Each
87637	Type 27 Pre-timed Controller.....	Each
87651	Magnetic Detector-Non-Directional.....	Each
87652	Magnetic Detector-Directional.....	Each
87661	Pressure Detector-Non-Directional.....	Each
87662	Pressure Detector-Directional.....	Each

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8768	Time Switch	Each
8769	Phase Overlap Relay	Each
8770	Pedestrian Push Button	Each
8771	Don't Walk—Walk Relay	Each
8773	Pedestrian Interval Timer	Each
8774	Magnetic Detector Relay Unit	Each
8775	Ballast for Mercury-Vapor Lamp	Each
8776	Isolating Transformer	Each
8777	Photo-Electric Control	Each
8778	Series-Multiple Transformer	Each
8798	Concrete Guard Post	Each
8799	Wood Guard Post	Each
8802	Barricades	Lineal Foot
8805	Highway Signing System	Lump Sum
8810	Sheet Aluminum Signs	Square Foot
8811	Extruded Aluminum Signs	Square Foot
8812	Plywood Signs	Square Foot
8816	Steel Structural Sign Posts	Pound
8817	Steel U Sign Posts	Pound
8818	Aluminum Posts	Pound
8819	Wrought Iron Posts	Pound
8820	Tubular Steel Posts	Pound
8821	Treated Timber Posts	M.b.m.
88251	Treated Timber Poles—Class 1	Lineal Foot
88252	Treated Timber Poles—Class 2	Lineal Foot
88253	Treated Timber Poles—Class 3	Lineal Foot
88254	Treated Timber Poles—Class 4	Lineal Foot
88255	Treated Timber Poles—Class 5	Lineal Foot
88256	Treated Timber Poles—Class 6	Lineal Foot
88257	Treated Timber Poles—Class 7	Lineal Foot
8830	Aluminum Overhead Structures	Lump Sum
8831	Steel Overhead Structures	Lump Sum
8832	Metal Overhead Structures	Lump Sum
8833	Changeable Copy Signs	Each
8895	Railroad Crossing Protective Signs	Each
8896	Advance Warning Signs	Each
8897	Warning Signs	Each

Re: 8816, 17, 19, 20. A fifth digit will be used to denote type of finish:

1—Black Iron

2—Black-Painted

3—Galvanized

9015	Steel Guard Rail—Square Wood Post	Lineal Foot
9016	Steel Guard Rail—Concrete Post	Lineal Foot
9017	Steel Guard Rail—Steel Post	Lineal Foot
9018	Steel Guard Rail—Round Wood Post	Lineal Foot
9023	Steel Median Rail—Wood Post	Lineal Foot
9024	Steel Median Rail—Concrete Post	Lineal Foot
9025	Steel Median Rail—Steel Post	Lineal Foot
9030	Aluminum Guard Rail—Square Wood Post	Lineal Foot
9031	Aluminum Guard Rail—Concrete Post	Lineal Foot
9032	Aluminum Guard Rail—Steel Post	Lineal Foot
9033	Aluminum Guard Rail—Round Wood Post	Lineal Foot
9040	Round Wood Guide Posts	Each
9041	Sawn Wood Guide Posts	Each
9042	Concrete Guide Posts	Each
9043	Type A Metal Guide Posts	Each
9044	Type B Metal Guide Posts	Each
9045	Type 2 Metal Guide Posts	Each
9046	Design A Guide Posts	Each
9047	Design B Guide Posts	Each
9048	Design C Guide Posts	Each
9049	Design D Guide Posts	Each
9070	Type 1 Jiggle Bars	Lineal Foot
9072	Iron Traffic Button	Each
9110	Project Marker	Each
9120	Station Marker	Each
9130	Right-of-Way Monument	Each

9205	Adjust Manholes	Each
9210	Adjust Catch Basins	Each
9215	Adjust Drop Inlets	Each
9220	Adjust Valve Boxes	Each
9225	Adjust Gas Shut-offs	Each
9230	Adjust Water Shut-offs	Each
9235	Adjust Water Inspection Plates	Each
9240	Adjust Gas Inspection Plates	Each
9304	Reset Fire Hydrant	Each
9305	Reset Cattle Guard	Each
9306	Reset R-O-W Monument	Each
9307	Reset Project Marker	Each
9308	Reset Station Marker	Each
9309	Reset Guard Rail	Lineal Foot
9310	Reset Miscellaneous Items	Lump Sum
9311	Reset Drop Inlets	Each
9312	Reset Utility Valves	Each
9313	Reset Curb	Lineal Foot
9314	Reset Water Valve Boxes	Each
9401	10" Cast Iron Pipe	Lineal Foot
9402	8" Cast Iron Pipe	Lineal Foot
9403	1.5" Cast Iron Pipe	Lineal Foot
9404	Repair Bridge	Lump Sum
9405	3" Galvanized Iron Pipe	Lineal Foot
9406	Pipe Railing	Lump Sum
9407	2" Galvanized Pipe	Lump Sum
9408	Pedestrian Staircase	Lineal Foot
9409	Small Bituminous Mixing Plant	Lump Sum
9410	Maintain Detour	Lump Sum
9411	Construct and Maintain Detour	Lump Sum
9412	Pump House	Lump Sum
9413	3" Galvanized Steel Pipe	Lineal Foot
9414	6" Galvanized Steel Pipe	Lineal Foot
9415	6" Cast Iron Pipe	Lineal Foot
9418	Roadway Finish Slab	Lump Sum
9443	Weigh Station	Lump Sum
9444	Traffic Counter Assembly	Lump Sum
9451	RCP Increases—12 in. to 18 in.	Each
9452	RCP Increases—18 in. to 24 in.	Each
9453	RCP Increases—24 in. to 30 in.	Each
9454	RCP Decreases—30 in. to 24 in.	Each
9455	RCP Decreases—24 in. to 18 in.	Each
9456	RCP Decreases—18 in. to 12 in.	Each
9457	RCP Decreases—48 in. to 24 in.	Each
9478	8" Spiral Weld Pipe—16 G	Lineal Foot
9501	Remove Structure	Lump Sum
95011	Remove Structure	Lump Sum
95012	Remove Structure	Lump Sum
95013	Remove Structure	Lump Sum
95014	Remove Structure	Lump Sum
95015	Remove Structure	Lump Sum
9502	Maintain Traffic	Lump Sum
9503	Remove Structure & Maintain Traffic	Lump Sum
95031	Remove Structure & Maintain Traffic	Lump Sum
95032	Remove Structure & Maintain Traffic	Lump Sum
95033	Remove Structure & Maintain Traffic	Lump Sum
95034	Remove Structure & Maintain Traffic	Lump Sum
95035	Remove Structure & Maintain Traffic	Lump Sum
9504	Revise Structure & Maintain Traffic	Lump Sum
9520	Remove Concrete Curb	Lineal Foot
9521	Remove Concrete Curb & Gutter	Lineal Foot
9522	Remove Concrete Gutter	Lineal Foot
9523	Remove Concrete Sidewalk	Square Yard
9524	Remove Concrete Pavement	Square Yard
9525	Remove Concrete Structure	Lineal Foot
9526	Remove Concrete Structure	Square Yard
9527	Remove Concrete Structure	Lump Sum

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9528	Remove Fire Hydrant	Each
9529	Remove Manhole	Each
9530	Remove Drop Inlet	Each
9531	Remove Headwall	Each
9532	Remove Wire Fence	Rod
9534	Remove Cattle Guard	Each
9536	Remove Signs	Each
9537	Remove Signs	Lump Sum
9538	Remove Guard Rail	Lineal Foot
9539	Remove Guide Posts	Each
9540	Remove Utility Valves	Each
9560	Remove Miscellaneous Items	Lump Sum
9561	Remove Snow Fence	Rod

A number will be placed as a suffix to the item number when it is necessary to bid upon the removal of several structures separately. Each structure will be given a Site Number (1, 2, 3, etc.) and that number will be the suffix in the fifth column. Thus 40013 will mean "Remove Existing Structure at Site 3."

9702	Stockpile Selected Surfacing	Cubic Yard
9703	Stockpile Selected Surfacing	Ton
9710	Stockpile 2" Type A Base Surfacing	Cubic Yard
9711	Stockpile 1½" Type A Base Surfacing	Cubic Yard
9712	Stockpile 1" Type A Base Surfacing	Cubic Yard
9715	Stockpile 2" Type B Base Surfacing	Cubic Yard
9716	Stockpile 1½" Type B Base Surfacing	Cubic Yard
9717	Stockpile 1" Type B Base Surfacing	Cubic Yard
9720	Stockpile 2" Type A Base Surfacing	Ton
9721	Stockpile 1½" Type A Base Surfacing	Ton
9722	Stockpile 1" Type A Base Surfacing	Ton
9725	Stockpile 2" Type B Base Surfacing	Ton
9726	Stockpile 1½" Type B Base Surfacing	Ton
9727	Stockpile 1" Type B Base Surfacing	Ton
9761	Stockpile 1" Type A Top Surfacing	Cubic Yard
9762	Stockpile ¾" Type A Top Surfacing	Cubic Yard
9763	Stockpile ⅝" Type A Top Surfacing	Cubic Yard
9764	Stockpile ½" Type A Top Surfacing	Cubic Yard
9765	Stockpile ⅜" Type A Top Surfacing	Cubic Yard
9767	Stockpile 1½" Type B Top Surfacing	Cubic Yard
9768	Stockpile 1" Type B Top Surfacing	Cubic Yard
9769	Stockpile ¾" Type B Top Surfacing	Cubic Yard
9771	Stockpile 1" Type A Top Surfacing	Ton
9772	Stockpile ¾" Type A Top Surfacing	Ton
9773	Stockpile ⅝" Type A Top Surfacing	Ton
9774	Stockpile ½" Type A Top Surfacing	Ton
9775	Stockpile ⅜" Type A Top Surfacing	Ton
9777	Stockpile 1½" Type B Top Surfacing	Ton
9778	Stockpile 1" Type B Top Surfacing	Ton
9779	Stockpile ¾" Type B Top Surfacing	Ton
9780	Stockpile ⅜" Cover Material	Cubic Yard
9781	Stockpile ½" Cover Material	Cubic Yard
9782	Stockpile ⅝" Cover Material	Cubic Yard
9783	Stockpile ¾" Cover Material	Cubic Yard
9784	Stockpile ½" Stone Chips	Cubic Yard
9785	Stockpile ⅜" Stone Chips	Cubic Yard
9786	Stockpile No. 4 Stone Chips	Cubic Yard
9790	Stockpile ⅜" Cover Material	Ton
9791	Stockpile ½" Cover Material	Ton
9792	Stockpile ⅜" Cover Material	Ton
9793	Stockpile ¾" Cover Material	Ton
9794	Stockpile ½" Stone Chips	Ton
9795	Stockpile ⅜" Stone Chips	Ton
9796	Stockpile No. 4 Stone Chips	Ton

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